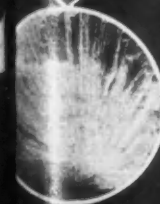


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JANUARY  
1947

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## Editorial:

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25¢

## Brains on the Auction Block

► CIVILIZATION depends more and more upon technically competent men and women to keep functioning the complex net work of interdependent services by which we live. The demand for technically competent persons presses ever harder upon a supply never too large in the first place, now sadly depleted by the dislocations of war.

The well-known law of S. and D., as a result, is operating with a ferocity that is popularly supposed to be found only in the jungle. Industries vie with each other for the bright youngsters coming out of college, and at the same time entice away from the colleges the professors who trained them. Colleges raid the secondary schools for teachers who should be kindling the enthusiasm of boys and girls for science. Schools rail in despair against the salary differentials that make it impossible for them to hold their faculties in such competition.

Far ahead in the ranks of those with money to spend stand the armed services, planning programs here, grating subsidies there, pensioning off the brightest lads in return for their unquestioning allegiance. In this mad scramble, where only money talks, it is needful for the student to ask himself as never before how he means to dedicate such abilities as he may have. At the moment this highly dynamic situation looks merely self-defensive and precautionary, but . . .

The example is fresh before us of Germany, a leader in technical competence, which went mad with self-centered pride in her ability to conquer the world. The steps by which she built up her fantasy of isolation, fear, defense and apparently self-preserving attack, a cycle familiar to psychiatrists, look deceptively innocent and logical. But the essence of militarism is fear, suspicion and secrecy, the very antithesis of the scientific method. Between the two there can be no compromise. Germany subordinated science to militarism and, in the end, lost both the war and science. Are we ready to put the scientific brains of our country in shackles to be sold to the highest bidder?

H. M. D.

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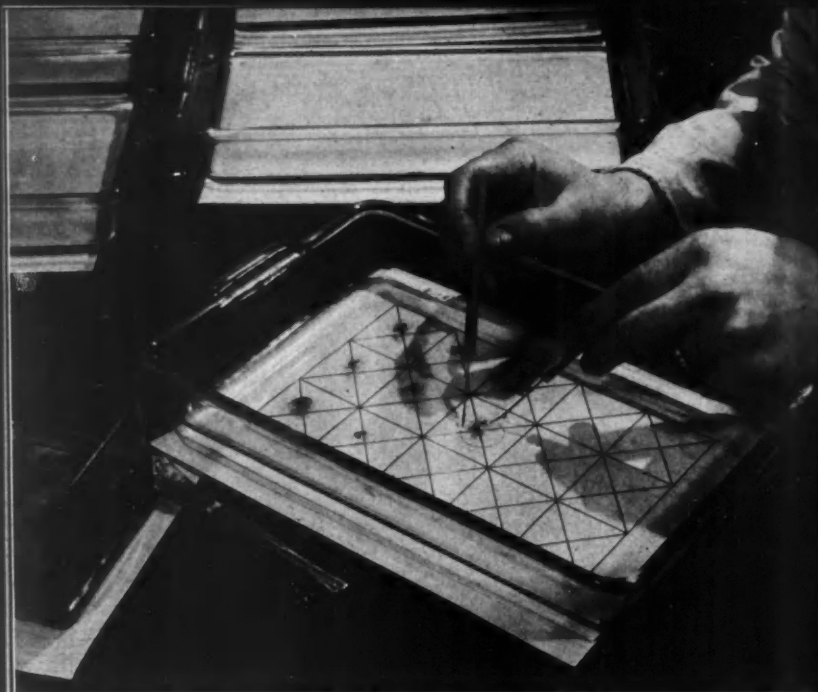
► SPECIMENS embedded in transparent plastic which has "jelled" are covered with a second layer. The whole slab sets to form a clear, transparent block which permanently mounts and protects the material to be examined.

## Preserved in Plastic

► UNSATURATED polyester resins have been found suitable for embedding delicate biological specimens. A program of search for a plastic material that would surround and protect soft animal and plant structures, that would clear the specimens so that internal parts could be seen, and that would be practical to use on a fairly large scale has been under way for several years at Ward's Natural Sci-

ence Establishment in Rochester, N.Y. They have succeeded in mounting such difficult specimens as pig embryos with the results shown in the accompanying photographs.

Mounted in the transparent plastic block, small objects can be examined from all six sides and large objects from at least the two major surfaces. They can be handled freely without fear of damage. Chick embryos, parts



► *SHOWING HOW bits of material to be embedded are spaced on the plastic layer, so that they may be at the center of convenient-sized blocks.*

of the cartilaginous skeletons of dogfish and mudpuppy, and even such fragile forms as jellyfish and liver flukes have been successfully embedded by Theodore Romaniak, who is in charge of this research.

Since, in the present state of the art, every type of specimen presents a new problem for its successful mounting, Ward's has adopted the policy of complete scientific publication of the details of the process by which their results have been achieved. They will continue experimenting with new preparations, and will offer for sale

successfully mounted specimens as teaching aids and museum material, under the name of "Bio-plastics."

The plastic adopted for this use is "Selectron," manufactured by the Pittsburgh Plate Glass Co. The literature of pioneer experiments in use of plastics for embedding specimens is reported as:

Knight, H. G., 1937, *Science* 86:333.  
Puckett, W. O., 1940, *Science* 91:625-626.  
Strumia, Max M. and Hershay, J. Ivan, 1944, *Science* 99:105-106.

Technical Service Report No. 4, Feb. 1, 1945, E. I. duPont de Nemours & Co. Embedding Specimens in Methacrylate Resins, U. S. Dept. of Agriculture Bulletin.



## The Process

1. The specimens may be fixed in Bouin's, formaldehyde, or any of the usual fixatives. All fixatives, however, regardless of the type used, must be completely removed. In the case of Bouin's, which is commonly used on embryos, the picric acid must be eliminated by washing in several changes of 70% alcohol. The first few changes should contain a small amount of saturated aqueous lithium carbonate. After all the yellow color has disappeared the specimens should be

transferred to water. Formaldehyde may be removed by washing in water.

2. After the specimens are washed in water, they are stained in acid carmine. The staining must be carried out to a point where internal structures are completely stained. De-staining is then carried to a point where the specimen is a light pink, since the plastic intensifies the color. Haematoxylin has been tried, but good staining has not yet been obtained with it.

► *AFTER THE SECOND layer of plastic has set under the proper heat treatment, the slab is sawed up into individual blocks, the edges ground and polished.*



The difficulty lies in adjusting the intensity of the stain, which is increased by the plastic.

3. The specimens are dehydrated in a series of alcohols (70%, 83%, 95% and absolute) the time depending upon the size of the specimens.

4. The next stage of the process, removing the alcohol, presented many difficulties. At first, various compatible solvents were tried, but these proved unsuccessful. The plastic in and around the specimens was diluted, producing internal strains resulting in cleavages and fractures in the blocks. To overcome this, the specimens are transferred from absolute alcohol to anhydrous ether, which displaces the alcohol, here again varying the time from an hour for early chick embryos to several hours for larger specimens.

5. The specimens are next transferred into the uncatalyzed monomer, and evacuated in a vacuum dessicator to draw off the ether, and allow the plastic to impregnate the specimen. This must be done very slowly and carefully until a vacuum is produced (500-700 mm. of Hg.) and left to stand until all the ether has been evaporated. Too rapid evacuation caused the ether to boil, destroying the specimens.

6. A quantity of the monomer is weighed and the catalyst (tertiary butyl hydroperoxide) added in the proportion of 0.1%—0.5% depending upon the size or thickness of the block. The lesser percentages of the catalyst are used as the thickness of the block

increases. The catalyst is stirred completely into the monomer and allowed to stand until all bubbles rise to the surface and break.

7. A supporting layer of the catalyzed monomer is poured into a Pyrex dish or tray and allowed to gel at room temperature, until it is firm enough to support the specimens. This requires from one to three hours.

8. The second layer is prepared in the same manner and poured onto the first.

9. The specimens then are transferred from the uncatalyzed monomer to the trays, being careful to carry over as little of the monomer as possible, and are then oriented on the first layer.

10. The trays are left to stand at room temperature, until the second layer has gelled.

11. After the gelatin is complete the tray are placed in an oven to cure for approximately 2 to 4 hours, the heat being raised slowly from 100° F to 250° F, remaining at 250° F for  $\frac{1}{4}$  to 1 hour.

12. After cooling, the blocks are easily removed merely by inverting the trays and allowing the blocks to drop out.

13. The plastic, being thermosetting, does not require any elaborate or special equipment for cutting, sanding or polishing. A fine-toothed band-saw is used for trimming and cutting. Sanding is done with abrasive belts,

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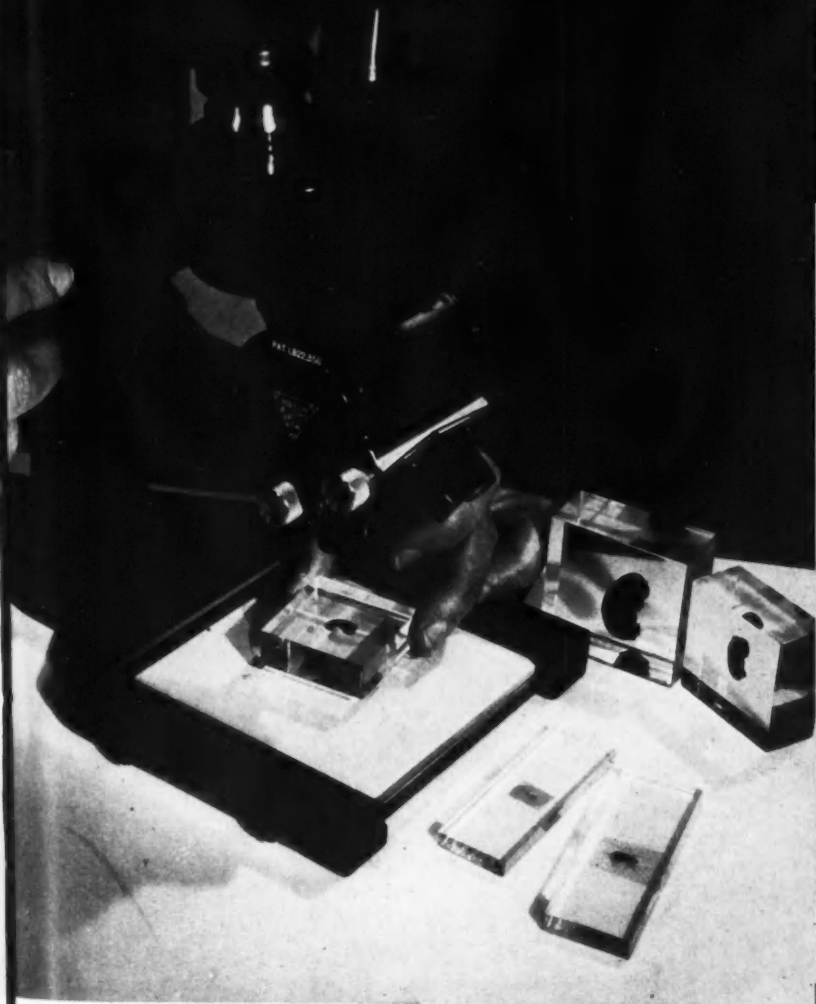
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► OBJECTS too thick to be pressed onto a microscope slide may be examined on all four sides when embedded in plastic. If the plastic surface becomes scratched by handling, fine abrasive and a buffing wheel will bring back the original transparency. Preparations of chick and pig embryos are around the microscope.

beginning with a coarse and finishing with fine. Polishing is done on a soft rag wheel using tripoli and rouge.

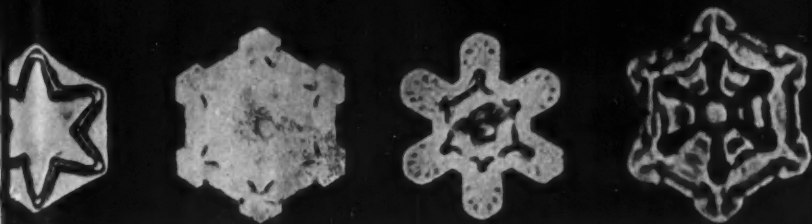
The process as outlined above has been applied successfully to the specimens mentioned. While no extensive experimental work has been done on other forms, which present different problems, we feel confident that in time these other forms can be embedded in this type of resin.

In general, the unsaturated polyester

resins are a light yellowish color, but some of these resins which are available in a purified form, while not as water-white as the methacrylates or styrene, have the advantage of a much simpler curing schedule. Occasionally, the blocks will have to be repolished. This can be done easily on a soft rag wheel or it can be done by hand using fine abrasives, polishin gcompounds. It will be found that by using a little care in handling and storage, much unnecessary work can be avoided.



► THIS PICTURE started all the excitement in our office. The photograph shows an exhibit of several biological specimens, including a type ear of Henry Wallace's hybrid corn, embedded in methyl methacrylate. The exhibit was held at the Department of Agriculture in Washington. The photograph was taken by Science Service Staff Photographer, Fremont Davis. The picture appeared in Chemistry for March 1945 and in an announcement in the Science News Letter about the same time. Apparently the whole world wants to know about embedding things in transparent plastics, judging from the avalanche of mail that resulted. And it seems to be easier to get plants and insects into the plastic than to get "the bugs" out of the process. The Department of Agriculture bulletin describing the preparation of specimens and their preservation in methyl methacrylate is scheduled for publication soon. The plastic used in Ward's method described and pictured above is of a different type.



► *MAN-MADE snow crystals were made to leave their imprints on plastic, to record their hexagonal shapes and characteristic modifications. These photographs and the ones on the back cover are enlargements of such imprints.*

## Crystallized Fog

► **ARTIFICIAL** man-made snow, recently created for the first time in a laboratory, may be made in the future to clear dangerous supercooled clouds over airfields.

Using dry-ice fragments against a cloud of supercooled droplets in a laboratory cold chamber, Vincent J. Schaefer, General Electric scientist, found that the droplets formed ice crystals that fell like snow.

In an airplane he then bombarded natural clouds with the solid carbon dioxide and succeeded in forming the crystals and clearing the clouds.

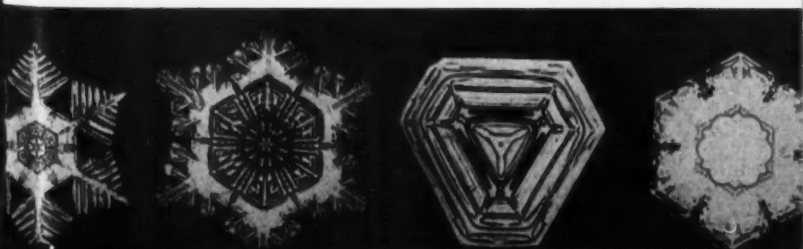
Maj. Gen. Curtis E. LeMay, chief of research and development for the Army Air Forces, is one of those interested in testing the artificial snow system, to learn whether this method

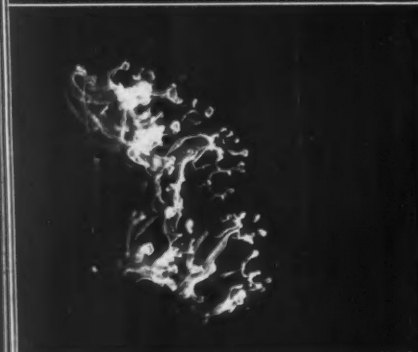
can be used to protect planes from the supercooled clouds which are one of the chief causes of icing on aircraft.

Mr. Schaefer first formed supercooled clouds by introducing moist air into a small commercial freezing unit with the temperature of the resulting cloud about minus 15 degrees Centigrade. When he hung a piece of dry-ice in the cooled cloud, the cloud was completely converted into ice crystals in 10 seconds. The crystals increased in size when more moisture was added. Examining the crystals under a microscope, Mr. Schaefer found they were similar to those of "diamond dust," the small natural crystals found on cold mornings.

In addition to using dry-ice as a source of ice nuclei, he used a rod

► *SNOW-FLAKES photographed from nature by the late Wilson J. Bentley of Jericho, Vt., who made a hobby of taking pictures to bring out the delicate tracery of these crystal forms.*





cooling in liquid air. When this passed through the supercooled cloud, it left behind a trail of submicroscopic nuclei that caused the cloud to dry up as the ice crystals grew.

Many clouds in the air are in "supercooled" condition. They contain water droplets whose temperature is below freezing, but which are not frozen. Science has not yet found the reason for this condition.

► FOG FORMS when moisture from the breath, puffed into a deep-freeze unit, condenses as super-cooled droplets. Crystals of dry ice introduced into the fog start the moisture crystallizing as tiny, scintillating snow-flakes. ▼

► STAGES IN CLEARING the fog, by inducing snow formation are shown at the left. At the top is the fog, a mass of super-cooled water droplets. The fairy-like forms in the second stage result from dropping a dry-ice crystal into the fog. As snow crystals form, the fog is consumed. A real snow-storm was recently induced by Vincent J. Schaefer of General Electric Co., who sprinkled dry-ice crystals onto an appropriate cloud. ◀



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## Political Difficulties Need Education in Tolerance

# International Atomic Energy Control

by J. WESLEY HOFFMAN

*Department of History, University of Tennessee.*

► THE SCIENTISTS who have produced the atomic bomb are intent upon frightening us. Those who know most about the bomb warn us that there is no defense against it. Its use not only gives the usual advantage to the aggressor but promises destruction to the nation which is on the receiving end of an attack. What advantage we may enjoy at the moment because we alone have the secret of atomic energy is fast being lost. Atomic bombs will soon be available, we are told, to any nation. This is all very alarming. The student of international relations finds it less disconcerting than the ease with which some atomic scientists arrive at the further conclusion that since the danger is so great there will be world control, perhaps some form of world state.

Social scientists of my generation have been saying since we returned from the armed forces after the first World War that there must be collective security, that in fact it was the only chance for security. We stumped the country for the League of Nations and the World Court. But alas! We remember the election of 1920, and the failure of the League and the Court to receive the approval of the United States Senate. We remember

also the disposition of the members of the League to use that organization to further their own nationalist objectives. Atomic energy is a wonderful and terrible force but it seems controllable and predictable in piles or in bombs. Who can predict or control the actions of Stalin, the French cabinet, the British Labor Party, the United States Senate or the powers that be in China? Social Scientists, too, are frightened men!

The Atomic Scientists have succeeded in convincing our government of the seriousness of its responsibility. It is no small responsibility to have released the greatest single destructive force in history! The government has approached the problem of the control of atomic energy in the same direct method it employed in producing atomic energy. The state department appointed the five-man committee which produced the Lilienthal report. On the basis of this report Mr. Baruch reported to the Atomic Energy Commission the United States proposal for the control of atomic energy. Mr. Gromyko promptly presented a Russian counter proposal which placed the problem of controlling atomic energy into the now familiar situation of bargaining (not to use stronger language) between Russian and her satellites with the United States, Great Britain and their satellites.

Presented as a part of the forum on atomic energy before the Tennessee Academy of Science at Vanderbilt University, Nov. 29, 1946.



Both plans purport to prevent the use of atomic energy for destructive purposes and to encourage the greatest possible use for constructive, peacetime purposes. On the means by which these general objectives are to be achieved there is considerable divergence. Whether the two sides can agree on compromise is by no means certain. It would seem that Mr. Baruch might be persuaded to accept most of the proposals of Gromyko's plan since these tend to be general. It seems less likely that Mr. Gromyko will accept certain rather specific proposals made by Mr. Baruch.

The Baruch plan calls for the creation of an Atomic Development Authority. This international Authority would have dominion over all deposits of uranium, thorium and plutonium. It would own and operate the plants which produce fissionable material. It would have exclusive right to experiment with atomic explosives. It would have free access for purposes of inspection to mines and plants in all countries. Finally the Authority would employ on its staff the best trained scientists of the world in order that it might remain in the forefront of scientific development in the field of atomic energy.

Mr. Gromyko proposes a sort of Kellogg-Briand pact to outlaw the use and manufacture of atomic bombs. Stock piles of bombs are to be destroyed. The United States is to share the know-how with other nations. Punishment of violations is to be left to the individual states.

For months, partly in the open and partly behind closed doors, negotiations have been going on to reach a

compromise between Russia and the United States. Some of the differences seem less formidable now than they did last June. On some points there is still wide difference of opinion.

Gromyko's proposal that laws be passed by the states to punish offenders need cause no obstacle but since the offenders most feared would not be citizens subject to national law but states beyond the control of such law the American demand is that there must be the possibility of imposing such serious penalties upon states as are now reserved to the Security Council. That body is subject to unanimity rule. One of the major states may veto *i.e.*, it may prevent the employment of sanctions. Mr Baruch adheres to his statement, "There must be no veto to protect those who violate their solemn agreements not to develop or use atomic energy for destructive purposes." It is possible that the veto issue is a point on which the American delegation may be willing to yield on a bargaining basis. If ten powers agreed to invoke sanctions against a recalcitrant power the result would be war whether an eleventh power exercised a veto or not. In the abstract, the veto seems less significant than it once did. It may well be that the effective guarantee for the outlawing of atomic weapons is to be sought more in a spirit of cooperation than in the formulation of formal procedures. It may be, however, that Mr Baruch will consider the surrender of the veto as the best sign of such a spirit of cooperation.

The main dispute seems in the meantime to have shifted to the matter of inspection. No nation can feel

secure against attack with atomic weapons unless such an agency as the Atomic Development Authority has free access to all countries and can inspect all mines and plants. The Russians have no love for foreigners snooping around their country. They point out that it would be possible for foreigners to pry into trade and military secrets through the inspection service of the Atomic Development Authority. On the matter of inspection it would seem negotiations have reached a most crucial issue. Collective security is possible only if effective guarantees can be achieved. Security rests upon a degree of good faith and trust between nations which seems to be largely lacking in the negotiations of the past months.

It should also be apparent at this point in the discussion that defense against atomic weapons is a part of the larger issues of war itself. It seems highly improbable that if nations reserve to themselves the right to make war and destroy the total strength of their enemies with every other resource at their command that they will not use atomic weapons. I am not arguing that we can not outlaw atomic weapons because they are a part of total war. I am arguing that it is necessary to consider the control of atomic weapons as a part of a larger problem of preventing war. This seems the more imperative in view of announcements that other weapons, even more deadly than the atomic bomb are being developed.

One further problem which has caused some differences in opinion in the Atomic Energy Commission may be worth mentioning, especially since

it was raised by Mr. Wallace. The issue concerns the timing of the destruction of atomic bomb stock piles and the release of secret information on the production of bombs. Russia demands that existing stock piles be destroyed within ninety days after ratification of the treaty. Since there has been such general demobilization of the army in the United States there seems to be a tendency to demand a demobilization of the army of Russia as a *pro quid quo* for destruction of our bombs. Thus again atomic energy control merges into the greater problem of general security.

On the timetable of release of secret information the American delegation seems to have clarified its position to the satisfaction of the Russians. Originally Mr. Baruch's statement seemed to imply that the United States would release information at its discretion and as it was satisfied that all the other powers had taken all the steps required for security. It appears now that the treaty is to contain a schedule of releases. If technicalities can be agreed to this point should offer no further trouble.

The summary just undertaken of the position of Russia and the United States gives some idea of the countless points of misunderstanding and the long and difficult negotiations necessary to achieve agreement; if indeed agreement can be reached. Behind all of the bickering there is still the concept of sovereignty. Russia seems very determined not to surrender any of those powers attributed to a sovereign state. She does not want to surrender vital freedom of action to any international body. Her experience at the

San Francisco Conference and at every international meeting since 1945 on most major issues is that she is in a minority against Great Britain and the United States. Sometimes she is opposed by lesser states with one or both western powers in the background.

Now what an irony that the United States should be critical of such a stand on sovereignty. The atomic scientists insist that the nineteenth century concept of national sovereignty must be abandoned. The American press is almost unanimous in its condemnation of Russia's use of the veto and other obstructionist methods. What a strange position for a nation to take which refused to join the League of Nations or to accept even with reservations the obligations of joining the World Court. On the other hand what assurance can Mr. Baruch offer that if he agreed to sweeping limitations on the freedom of action of the United States he or his chief, the Secretary of State, could persuade the Senate to ratify such an agreement? One good reason for the inclusion of the veto provision in the security council was that the shrewdest political mind on the American scene considered it necessary to make the Charter palatable to the Senate of the United States. There probably has been no fundamental change in the thinking of the American people on that issue.

I do not want to be misunderstood. I favor collective security. I favor the Baruch plan. I do not see how we can have a reign of law in international affairs in place of the present anarchy without abandonment of the extreme defense of national sovereignty. It is

an outworn concept but many people whose votes are counted and who have a voice in the council of the mighty still support the idea that we must surrender to no international authority the right to make any vital decision for us. If you don't believe this I suggest that you listen to the conversations at service clubs, veterans meetings or the speeches of your representatives in Congress.

If the problem of the international control of atomic energy could be isolated as the plants at Oak Ridge and Hanford were isolated it would be a simple thing to solve that problem. Men of good will freed from the influences of the complicated maze of restrictions and pressures of national and international politics could certainly agree on international control of atomic energy. Unhappily such isolation is not possible. Each member of the Atomic Energy Commission is the representative of a state which is playing a complicated game of power politics. Taken by itself and as seen in the United States the Baruch plan is a very generous proposal by a nation which has the bomb. Seen from the point of view of the American lead in the production of atomic energy in conjunction with America's lead in aviation, with the American industrial potential, American bases in the Pacific, America's occupation of Japan and part of Korea, America's aid to Nationalist China and America's position in the near East and in Europe the plan seems less generous. The Russians choose to see it from the latter perspective.

To us the Russians seem to be play-

ing a desperately dangerous game. It frightens us the more because it is carried on behind the iron curtain of secrecy. We would like to know, is Russia still intent upon overthrowing capitalism? Are the men who make up the politburo still devoted to the gospel of communism or have they been converted to nationalism and an imperialism akin to the old Czarist imperialism? That colossus, the Russian bear, has certainly upset the balance of power in Asia, in the Near East, and in Europe which has characterized the past century. This has created a terrible uncertainty on the part of the Western Powers. They are loath to surrender any advantage they enjoy. They are, I believe, anxious to replace the balance of power concept with any practical plan for collective security.

Seen from the Russian side the situation is probably equally uncertain. Russian journalists speak of western secretiveness behind the plush curtain. The Russians find it difficult to forget that Russia was isolated by a cordon sanitair after the last war. They are not unaware of Western hostility to communism. They choose to think that the western powers would have preferred Hitler to Russia in 1939. They insist on seeing British and American imperialism blocking them at every turn. With such attitudes of suspicion and fear of Russia for the West, and the West for Russia, the process of making and preserving the peace is bound to be slow. Every incident of misunderstanding becomes occasion for accusations and counter accusations of bad faith and villainous intent. It will take a long time and

much international good will to achieve a basis for cooperation and collective security. Where and when this requires concessions or where and when the policy of "getting tough" produces the best results it is difficult to say. President Roosevelt in his "great design" seems to have staked everything on winning Russia for an effective United Nations organization by concessions. He is said to have conceded the failure of his policy before his death. The policy of the State Department seems to have changed. It remains to be seen whether the new policy will produce better results than its predecessor.

It is not the purpose of this paper to outline a new American foreign policy. Neither is it my purpose to praise or condemn past or present policies. It may not be amiss to make four suggestions for the attitude of laymen.

1. I would suggest the need for tolerance. It is always easy to understand and defend the policy of one's own country. To appreciate the policy of other countries, particularly rival countries, requires more effort. One of the greatest needs of the world today is the willingness of the public to see ourselves as others see us.

2. I would suggest that it is probably going to take a long time to work out solutions of the many international problems of this post-war age. It would be a mistake for governments to permit aimless drifting. On the other hand, the settlement of international problems requires much time. The way of international agreement is the slow way of facing issue after issue and seeking the greatest common benefit in settlement.

3. I would suggest an educational campaign in schools, universities and on the adult educational basis. International problems are intricate. They are growths out of deep roots of history and tradition, of verbal interests and prejudices. They can be understood only through careful study. Only a well informed public provides a safe basis for democratic government.

4. I would suggest that the influence of individuals and groups be dedicated to the promotion of the greatest possible degree of interna-

tional cooperation. The organization of international agencies is important. The development of a spirit and a habit of cooperation is even more important. Every effort should be made to further international control of atomic energy. The fullest possible cooperation should be achieved through the United Nations. Success under the present charter should lead to a revision in favor of a stronger, more effective organization in the future. World law must replace the present condition of international anarchy.

## *Protons Accelerated to New High*

► PROTONS, the nuclear particles which scientists are grooming as the most powerful puncher in atom-smashing, have been accelerated to a new high energy of 15,000,000 electron volts at the University of California.

Significantly, this top power was achieved in a pilot experiment in Prof. Ernest O. Lawrence's 85-ton cyclotron, which a little more than 10 years ago was the world's only big league atom-smasher but has now been dwarfed by a succession of giant machines.

Fifteen million electron volt protons were achieved using the new frequency modulation principle, which will be applied to the 4000-ton cyclotron now nearing completion. Eventually this machine is expected to be able to accelerate protons to 350 million electron volts.

Technical difficulties have always made it more difficult to speed up protons to the high energies of less tem-

peramental nuclear particles such as deuterons (heavy hydrogen nuclei) and alpha particles (helium nuclei). For this and other reasons, deuterons and alpha particles have been most widely used.

Frequency modulation, suggested by Prof. Edwin M. McMillan, makes it possible to adjust the timing of accelerating electrical impulses to fit the characteristic revolutions of protons as they are pushed around the circular orbit in the cyclotron chamber. This was proved in the pilot experiments with the 85-ton cyclotron.

One of the reasons the proton is considered to be the most promising atomic bullet is that the proton itself is a basic particle of the nucleus.

The experiments in which the new proton energies were achieved were conducted by Drs. J. Reginald Richardson, Kenneth R. MacKenzie, E. J. Lofgren, Fred Schmidt, and Byron T. Wright, of the Berkeley Radiation Laboratory.

Conditions Met on Earth  
Unusual in the Universe

## Atomic Energy Common, Fire Rare

by WILLIAM G. POLLARD

Department of Physics, University of Tennessee

► FIRST I want to say something about what atomic energy is. Perhaps the best way to do this is to compare it with the more familiar chemical energy. Chemical energy is the kind of energy released when coal, wood, or gasoline is burned or when TNT explodes.

We get chemical energy because things called atoms exert forces on each other and get drawn together by these forces into groups called molecules. In chemistry the different kinds of atoms are called elements. Some of the elements are hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, and oxygen, to name them in order of increasing weight. Air is made up primarily of oxygen and nitrogen. But not in the form of atoms. Two oxygen atoms attract each other and pull together to form a molecule of oxygen in the form of a dumbbell. Nitrogen and hydrogen atoms do the same thing. They form groups of two held together fairly strongly.

Coal is made up of carbon atoms. Let us see what happens when coal burns. A carbon atom, when it comes close to two oxygen atoms held together as an oxygen molecule, is strongly attracted to the mid-point be-

tween them. The strong force pulling it into place causes both to move rapidly toward each other. They vibrate very rapidly as a result and this excessive motion is transferred to other molecules which strike the group. All this excessive motion appears to you as great heat. This is what burning coal consists of. The oxygen molecules attract carbon atoms as a magnet attracts a nail. Under this force, the particles are speeded up, vibrate rapidly, and transfer this excess motion to other atoms and molecules. When these others move rapidly we say they are hot. We say the coal is burning. The result of this burning is to fasten the carbon atom and the oxygen molecule into a group of three atoms called a molecule of carbon dioxide.

At the center of every atom is what we call the nucleus of the atom. It is about 100,000 times smaller than the atom and contains most of the weight of the atom like the solar system and the sun. Back in 1930 we found that the nucleus was made up of smaller particles called neutrons and protons. These are held together by strong forces in groups of several neutrons and protons and such groups form the nuclei or cores of all atoms. Now just as chemical energy comes from some groups of atoms pulling together to form new groups, atomic

Presented as a part of the forum on atomic energy before the Tennessee Academy of Science at Vanderbilt University, Nov. 29, 1946.

energy comes from some groups of neutrons and protons pulling together to form new groups. Nuclear physics is therefore very much like chemistry. In one we have certain elements called atoms which pull together into groups called molecules. In the other we also have elements, but there are only two of them called neutrons and protons. These two pull together to form groups. These groups we call atomic nuclei or isotopes instead of the corresponding word molecules in chemistry. We have different isotopes of the same chemical element by having groups with different numbers of neutrons and the same number of protons.

The one big difference between chemical and nuclear reactions is the amount of energy involved. The forces holding neutrons and protons together are enormously greater than those holding atoms together in molecules. When two or more nuclear particles are pulled together to form a new nucleus or isotope, the speeds which these forces impart to them are beyond anything in our experience. In general they are about a million times greater than the speeds acquired when atoms go together to form molecules.

To pull a bar of steel apart you have to overcome the forces which iron atoms exert on each other in holding it together. In terms of the corresponding force you would have to exert to pull the nucleus of an atom apart, split it, say, these nuclei of atoms are several million times stronger than steel.

We can look at it this way: When coal is burned, the speeding up of the atoms corresponds to heat energy of

about 4 kilowatt hours per pound of coal burned. Burning fifty pounds of coal releases 200 kilowatt hours, or about the electric bill of an ordinary household for a month. Now the nuclei of the atoms of the metal lithium at very high temperatures and pressures will unite with hydrogen atoms or protons to form two nuclei or atoms of helium. This is a nuclear reaction. The two helium atoms fly apart with enormous speeds under the forces acting on the nuclei. The speed is so great that the resulting heat energy is 30,000,000 kilowatt hours per pound of lithium burned, enough to run our ordinary residence twelve and a half thousand years!

The burning of one ton of coal will keep the power plant at the University of Tennessee running for about two hours. If there were any practical way to burn lithium with hydrogen, (there is none, as we shall see shortly), one pound would keep it going for a year. There is, however, a kind of nuclear furnace called a "pile" which burns uranium with neutrons instead of lithium with protons which is in operation now at Oak Ridge. This plant produces just about the same amount of heat all the time as our University power plant does. It is in roughly the same size building as our power plant and they both have roughly the same output. It has been operating pretty nearly continuously for almost three years now and during that time it has consumed around five pounds of fuel. Compare this with the amount of coal consumed in the University power plant in the same time!

There are three points I wish to



make now. The first concerns the impression that atomic or nuclear energy is a very rare thing only just now discovered and that chemical energy as in burning wood or coal is very common. It is, in fact, just the reverse. There are many nuclear reactions in addition to joining lithium and hydrogen which can give these enormous quantities of energy. They are extremely common in the universe. They are going on today in most of the matter in the universe. All of the heat poured out of the sun and all other stars comes from these reactions. In most of them hydrogen is being burned to form helium. Ordinary fire, on the other hand, is almost certainly extremely rare. It requires an atmosphere containing free oxygen and supplies of free carbon that can only come from living matter. So far as we know, our own earth is the only place in the whole universe where it can occur.

Why, then, have men not produced it before? To start an ordinary fire you have first to ignite it, that is, produce a high temperature in one spot. A nuclear fire requires the same thing except you have to produce a temperature of several million degrees. In the sun the reaction is just barely ignited and the temperature is 35,000,000 degrees Fahrenheit. All nuclear reactions with naturally existing materials will burn only at temperatures like this. They also require pressures of many millions of pounds per square inch. You may be sure that we will never use this kind in anything but bombs. Our sun is really an atomic bomb in process of continual explosion.

How, then, can we have atomic

power plants? There are quite a number of things like lithium, boron, nitrogen, uranium, and plutonium that can be burned or reacted with neutrons. They give about the same amounts of energy as the nuclear reactions with naturally existing materials not using neutrons. But they do not need high temperatures at all to ignite them. They burn at any temperature as soon as the neutrons are supplied.

The trouble is that there is no natural source of neutrons except in one special case. The nuclei of the heaviest elements are right on the verge of blowing up because of the repulsive forces pushing apart the large number of protons in them. A slight disturbance upsets the balance and the nucleus splits in two. This is called fission. When it happens several neutrons are set free. From a knowledge of the way neutrons are held in all nuclei we can say with assurance that the only way we can make neutrons reproduce themselves and so get great quantities of them is this kind of process.

This brings me to my second point. Most of the heavy atoms such as thorium, protoactinium, and uranium can be split with relatively small disturbances but only a few will do so under the particular disturbance caused by capturing a neutron. In fact, only one existing in nature will do so and this is a kind of uranium consisting of 92 protons and 143 neutrons bound together so as to have 235 particles in it. It is an isotope of uranium which we call uranium 235. The common form has 238 particles in it. This makes uranium the key to

all applications of atomic power. Other materials, like plutonium, which are just as good as U-235 can be made from U-238, and from thorium, but you have to have lots of neutrons to do it and these can only be had from uranium.

It is difficult to appreciate the force of these arguments without a background in nuclear physics but they are really foolproof. Many new and remarkable things will be done with atomic energy which we do not foresee at all now. But this we know, they must all of them start with a heavy element and very probably this element must be uranium. It will be the key to everything. This is the one very fortunate circumstance in the whole disturbing problem of the atomic bomb.

There is a further point of import-

ance. The kind of reaction used in a bomb needs nearly pure U-235 or plutonium or other fissionable isotope. That used in a pile such as the plant at Oak Ridge I told you about is very similar and uses the same fissionable isotopes but they do not have to be pure. They can even be at fairly low concentrations. This means that after making fissionable isotopes other non-fissionable isotopes of the same chemical form can be added. They are then no good for bombs but still good for atomic power plants. So you can denature bomb material, making it useless for bombs but still good for peacetime uses.

These two circumstances—that uranium is the key and that denaturing is possible without harming peacetime applications—form the technical basis of the possibility for controlling atomic energy.

### *Research at Associated Universities*

► **WORLD'S LARGEST** cyclotron and synchrotron and a uranium pile for producing radioactive elements for laboratory work are planned for the new Associated Universities, Inc., that is going to turn the former Army camp at Camp Upton, N. Y., into an atomic research center, Dr. Philip M. Morse, professor of physics at Massachusetts Institute of Technology and newly appointed director of research for the institution, disclosed.

A cyclotron of 500,000,000 volts and a synchrotron of comparable size are among the items of equipment scheduled to be constructed, Dr. Morse reported.

Ten to twelve buildings will house biological, chemical, physical, medi-

cal and engineering research groups on the 3,700-acre tract. About 1,000 persons will comprise the community, including both technical and non-technical personnel.

Associated Universities, Inc., is sponsored by nine universities: Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania, Princeton, Rochester and Yale. Edward Reynolds of Harvard is president of the new university, and the project's scientists will not be limited to the cooperating schools.

Dr. Morse emphasized that pure research looking to peacetime applications of atomic energy will be the primary purpose of the project.

## Xenon Produces Numbness During Altitude Experiments

# Rare Gas an Anesthetic

► ONE OF THE rarest gases, xenon, which forms about one 170-millionth part of the atmosphere, has possibilities as a new, non-explosive anesthetic, it is indicated by recently released University of California wartime research.

In "tracer" experiments with radioactive xenon, a group of researchers in the Aero-Medical Unit found that the inert gas has narcotic effects on human subjects as well as mice.

In addition to finding obvious physical anesthetic effects, the researchers took radio-autographs of mice fed radioactive xenon, and found that the gas had permeated the spinal cord and whole nervous system in the characteristic manner of anesthetics.

With the radio-autograph technique, the mouse literally takes his own picture after being sacrificed. Selected slices of tissue are placed on a photographic plate, and the radioactivity produces a picture similar to an X-ray, showing the distribution of the substance.

The anesthetic quality of xenon was discovered when the group of scientists were studying high-altitude sickness. In studying the effect of rare gases on human subjects, they received complaints of dizziness and numbness by subjects breathing a mixture

of krypton and oxygen at atmospheric pressures.

This set the scientists on the following chain of reasoning: first, nitrogen, somewhat similar in properties to krypton and xenon in the inert gas family, causes dizziness and numbness at high altitude, the reason being that it dissolves rapidly in the body in a rarefied atmosphere but not at sea level; second, xenon is much more soluble in the body than either krypton or nitrogen; third, therefore xenon might be anesthetic at sea level.

The reasoning proved to be correct, a mixture of 70% xenon and 30% oxygen producing in mice temporary staggering, stupor and paralysis.

Because xenon is extremely rare and no economical method is known of separating it from the air, detailed experiments could not be conducted on human subjects. This factor may also make it more difficult to develop the gas as a practical anesthetic.

The scientists said that while the effect of xenon alone is not enough to produce prolonged anesthesia, it may be possible to obtain such an effect by mixing it with another substance.

Dr. John H. Lawrence, assistant professor of medicine, performed the experiment with the assistance of Drs. H. B. Jones, C. A. Tobias, and J. G. Hamilton.

Dry distillation of wood in making charcoal, if all the by-products are collected and sold, is more profitable than turning the wood into pulp, it is claimed by some wood chemists.

## For the Home Lab

# Fragrance of Hyacinth

by BURTON L. HAWK

► DEEP IN THE HEART of every home chemist, whether he admits it or not, is the secret desire to make perfumes! For who does not enjoy a pleasant scent? And for the chemist, who is so familiar with evil smells, the pleasant scent should be doubly enjoyable.

In previous articles we have dealt with the fragrance of fruits, nuts, and spices. Now we shall direct our attention toward flowers. Many compounds can be prepared in the laboratory which duplicate the fragrance of popular flowers and the chemist utilizes these compounds as the basis for synthetic perfumes. One such compound is phenylacetaldehyde which possesses the delightful odor of hyacinths. It is made from cinnamic acid by treatment with hypochlorous acid and dilute sulfuric acid.

Our first step, then, is to prepare cinnamic acid. The famous chemist, Perkin, devised a method of synthesizing the compound by heating together sodium acetate, benzaldehyde, and acetic anhydride. We shall do likewise. Place 2 grams of *dry* potassium acetate in a flask. (It has been found that a better yield is obtained more quickly by using potassium acetate in place of the sodium salt.) Ordinary crystalline potassium acetate can be dried by heating gently in an evaporating dish with occasional stirring until all vapor is driven off and the salt is completely fluid. Allow the mass to solidify, grind to a powder in

a mortar, and use immediately. Add to the potassium acetate in the flask 5 cc. of acetic anhydride and 3 cc. of *freshly distilled* benzaldehyde. (When distilling benzaldehyde, add small pieces of clay plate or glass beads to prevent bumping.) Mix the ingredients thoroughly and heat the flask allowing the solution to boil gently for at least a half-hour. If irritating vapors bother you, do not become discouraged. Open a window and carry on! At the end of the designated time, remove the flame and add 10 cc. of hot water to the contents of the flask. Add cautiously; the action may be somewhat vigorous. The mixture should now be steam-distilled until all unchanged benzaldehyde is removed (see below). However, if you do not have the facilities for doing this, it may be eliminated. Merely heat the solution to boiling again for 10 or 15 minutes. Then filter the hot solution quickly and heat the filtrate again to boiling and add a few cc. of hydrochloric acid. Allow the solution to cool, stirring occasionally. Cinnamic acid will crystallize out. Remove the crystals by filtering and redissolve in hot water. Cool and recrystallize. Repeat this operation several times to obtain a purer product.

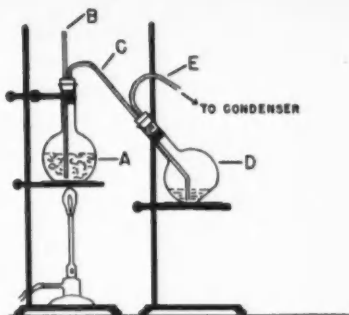
In describing this experiment we are taking into consideration the limited facilities of a home laboratory. Naturally, a 100% pure product cannot be expected. Much better results can be obtained by using an air-cooled

reflux condenser, heating the flask in an oil bath, steam distilling, and filtering with suction. But if such set-ups are not available, the home-chemist must not assume an attitude of discouragement; he must improvise.

Stir about  $\frac{1}{2}$  teaspoonful of bleaching powder (chloride of lime) in 50 cc. of water. Allow the solid matter to settle, and pour off the clear solution. Prepare a solution of cinnamic acid by adding a small amount of the acid to 10 cc. of hot water. Heat further, if necessary, to dissolve as much as possible. Add to this an equal amount of the clear bleaching-powder solution. The reaction produces a compound known as phenyl- $\alpha$ -chlorolactic acid:  $\text{C}_6\text{H}_5 \cdot \text{CH} : \text{CH} \cdot \text{COOH} + \text{HOCl} \rightarrow \text{C}_6\text{H}_5 \cdot \text{CHOH} \cdot \text{CHCl} \cdot \text{COOH}$ . Add a small quantity of dilute sulfuric acid to the mixture and heat gently. The result: phenylacetaldehyde:  $\text{C}_6\text{H}_5 \cdot \text{CHOH} \cdot \text{CHCl} \cdot \text{COOH} \rightarrow \text{C}_6\text{H}_5 \cdot \text{CH}_2\text{CHO} + \text{HCl} + \text{CO}_2$ . But what's in a name? . . . that which we call a hyacinth, by any other name would smell as sweet. . . .

The Perkin synthesis of cinnamic acid is another example of a *condensation* reaction, similar to the preparation of cinnamaldehyde, as described in a previous article. But whether the actual condensation takes place with the acetate salt or with the acetic anhydride is a matter open to question. And just how much our patient reader is concerned with how the condensation takes place is also a matter open to question!

The crater of the positive carbon in a carbon arc light, similar to those used for motion picture projection screens, generates the most intense light known.



Steam Distillation

### Steam Distillation

In many organic experiments, it is desirable to purify compounds by steam distillation. A simple method of doing this is shown in the accompanying diagram. Steam is generated in flask A by heating water and is conveyed via tube C into the liquid to be distilled in flask D. Tube B, extending almost to the bottom of the steam-generating flask, acts as a safety valve. The distillate passes through tube E which leads to a condenser or to a flask immersed in cold water (not shown). Make sure all connections are tight. It may be necessary to heat flask D gently to prevent too much condensation. When distillation is completed, disconnect tube C *before* removing heat from flask A; otherwise contents of flask D may be sucked back into the generator.

## Paper Mill Waste for Yeast

► PLANS TO USE waste sulfite liquor from paper mills in the production of yeast are being developed in Wisconsin. If successful, this program will not only bring added revenue to mills amounting to millions of dollars, but will also do much to eliminate stream pollution in the paper mill areas.

A total of 12 companies, 11 of them Wisconsin paper firms, have organized the Sulphite Paper Manufacturers Committee on Waste Disposal, and are cooperating with the Institute of Paper Chemistry at Appleton, Wis., in research on this subject. A chemist has been sent to Germany to study plants there.

A process has been developed which allows yeast from sulfite liquor to be

used for animal feeds, principally poultry at this time, although feeds for cattle are also seen likely. There is a possibility that foods good for human consumption may be reclaimed from the waste.

The yeast process uses the wood sugars in sulfite pulping liquors, and further research may, it is hoped, find uses for the lignin solution which remains. A site is now being sought for an initial reclamation plant for the research.

The Marathon Corporation, one of the cooperating group, is already reclaiming a number of by-products from these wastes, including water softeners, chemicals for aiding concrete mixing, plastics and vanillin.

## Widespread Radioactivity Not Traced

► NEITHER OF the two atom-bomb explosions at Bikini caused sufficient pollution of the air with radioactive matter to be traceable by super-sensitive instruments in its terrestrial magnetism laboratories near Watheroo, Australia, near Huancayo, Peru, and at Tucson, Ariz., the Carnegie Institution of Washington reports. Calculations based on the quantity of air into which radio-active particles would be dispersed after such an explosion indicate extreme improbability of enough of them getting into one locality to be registered instrumentally.

Only once did instruments at a Carnegie Institution observatory show a change in the electrical conductivity of the air that might possibly have been traceable to an atom-bomb explosion. A week after the test at Alamogordo, N. M., on July 16, 1945, the instruments at Tucson, 300 miles to the west, showed abnormally high conductivity for parts of three days. However, since records for former years show almost equally high rates without any A-bomb explosions to account for them, even this must remain a doubtful instance.

Rotting apples under fruit trees should be picked up and removed or they may hold over for the next season diseases that might affect the new crop.

**Natural Mold Chemical  
Duplicated in Laboratory**

## Penicillin Synthesis Achieved

by JANE STAFFORD

► NEW AND BETTER penicillins are expected as a result of the duplication in the laboratories of this mold chemical, announced by chemists of Cornell Medical College.

The scientists who synthesized penicillin and are now at work synthesizing new penicillins are Prof. Vincent du Vigneaud and associates, Frederick H. Carpenter, Robert W. Holley, Arthur H. Livermore and Julian R. Rachele.

Chemical remedies for such still-unconquered diseases as tuberculosis, the common cold, influenza and infantile paralysis may be forthcoming, now that chemists have learned how to synthesize penicillin and to change and perhaps improve its chemical make-up. That is something the mold itself could not do.

Synthetic penicillin is still a laboratory product. The very small amount of 10 milligrams is all that has been made so far. It takes over 30,000 milligrams to make an ounce. There is no chance whatsoever of commercial production of synthetic penicillin at the present time, Prof. du Vigneaud told me. He pointed out, however, that throughout the history of chemistry it has usually been the case that if a substance can be synthesized at all, the method can be improved and commercial production becomes possible.

An unusual feature of the synthesis of penicillin is that it was done with-

out knowing the exact architecture of the penicillin molecule. Ordinarily, chemists start with knowledge of this architecture, called a structural formula, and proceed to build up the molecule.

All during the war American and British chemists, working in the secrecy demanded by military security, tried to learn the architecture of the mold chemical that was saving battle-wounded and, later, civilian victims of deadly infections.

In the early stages, the majority of chemists favored an oxazolone-thiazolidine structure. Scientists at Oxford University in England and at Merck and Company in the United States independently and almost simultaneously in the first months of 1944 obtained a chemical of this architecture which had anti-germ activity like penicillin's. But they had such minute amounts of material that some of the scientists collaborating on this war research thought the antibolic activity might be due to something other than penicillin.

The architecture of the compound they were working with, it then turned out, was probably not correct for penicillin. That was the situation in January, 1946, when the OSRD contracts terminated. Up to that time, 38 groups of scientists, 17 in Britain and 21 in the United States, had been working on the problem under OSRD and British Medical Research Council auspices.



In the first few months of 1946, Prof. du Vigneaud and his associates succeeded in isolating crystalline penicillin and proving its identity with the natural product.

One of the first things they did to prove their synthetic white crystals really were penicillin was to compare their activity against seven different bacteria with that of natural penicillin. The two penicillins had the same action against bacteria.

Having passed this bacterial spectrum test, synthetic penicillin was next put through a really tough one. This was the excretion test in which the same amounts of natural and synthetic penicillin were given to rabbits and the amounts of each which the animals excreted were measured. The ratio of excreted penicillin to the dose was the same for both penicillins.

Radioactive sulfur was used in preparing another batch of synthetic penicillin. Natural penicillin was added and then isolated as the triethylammo-

nium salt. This salt contained radioactive sulfur and held it through two recrystallizations and through conversion to two derivatives.

When the enzyme, penicillinase, which rapidly inactivates natural penicillin was added to the synthetic, this was inactivated in the same way. Synthetic penicillin also showed the absorption band in the infrared region characteristic of natural penicillin.

Part of the battle to prove that the synthetic material actually was penicillin consisted in fractionations to "fish out the active material in higher and higher concentrations," Prof. du Vigneaud explained. His group finally succeeded in obtaining synthetic penicillin at a concentration of 270 units per milligram.

"Particularly noteworthy," he points out, is the fact that the synthetic penicillin finally obtained is the same optical isomer as natural penicillin although there could be about eight isomers of penicillin.

## *Instrument Reveals Chemical Structure*

► THE CHEMICAL content and structure of the molecules of materials other than metals are revealed by a new instrument. A special type of infrared spectrograph designed by Dr. Donald K. Coles of the Westinghouse Research Laboratories automatically determines how much of what chemical is in an unknown material and shows the molecular structure.

Heat rays in the infra-red region of the spectrum are beamed through the material to produce an absorption pattern, revealing what wavelength or

frequency of radiation has been absorbed. This determines the presence of a certain structural element and the amount is disclosed by the amount of absorption.

The push-button-operated instrument cannot be used for metals but is used for liquids, gases and many solids, including plastics. Dr. Coles says that the new spectrograph also is valuable for fundamental research in showing the molecular structure of materials.

## Chem Quiz

### When Did We Find Them?

► WE HAVE KNOWN some elements a long time, and others we have met only recently. Can you discover when the following discoveries were made? If not, you will find the answers on page 38.

1. Which seven metals were known to the ancients?

2. What four elements have not been discovered yet?

3. What four new metals have been made by transmutation?

4. Which element was discovered during the Dark Ages (and used for Dark Deeds)?

5. What are the first two elements discovered by the human race?

### *Anti-Caries Mouth Rinses Get Trial*

► HOPE THAT tooth decay may be prevented by use of an ammonia-containing mouth rinse and tooth powder appears in a report which four University of Illinois scientists gave at a recent meeting of the Chicago Dental Society.

The four scientists are Dr. Robert G. Kesel, Dr. Joseph F. O'Donnell, Dr. Edward C. Wach and Dr. Ernst R. Kirch. The paper announcing their studies won the dental society's annual \$500 essay competition award.

Don't start using the household ammonia from the kitchen or the spirits of ammonia in the medicine chest for a private campaign to protect your teeth from decay. Those are not the kinds of ammonia used in the studies. The prescriptions for the anti-caries tooth powder and mouth wash call for ammonia in the form of dibasic ammonium phosphate.

Also, the rinse and powder are still on trial and it will be 18 months to two years before the scientists are sure these can prevent tooth decay. Patients who have been using them say their

mouths feel "exceptionally clean" and dental examinations show that their teeth are notably free of white matter and deposits usually present in cases of active decay.

Even more encouraging, those using the ammonia preparations have shown a marked reduction in the number of *Lactobacilli acidophilus* in their mouths. These micro-organisms are used as a "yardstick" of susceptibility to tooth decay.

The idea for using ammonia compounds to prevent tooth decay came from findings Dr. Kesel and associates announced to scientists almost a year ago.

Immunity to caries, or tooth decay, those earlier findings suggested, comes from tiny amounts of ammonia continuously present in the mouth. The ammonia comes from a small group of the protein building-blocks known to scientists as amino acids. The lucky persons who are immune to caries have in their salivas enzymes capable of producing ammonia from certain of these amino acids.

## *New Methods in Induction Heating*

► **HIGH-FREQUENCY** induction heating in American metal plants takes a step forward with a new development of an ignitron frequency converter for melting furnaces and forging heater applications. The new converter was revealed at the National Electronic Conference by R. J. Ballard and J. L. Boyer, Westinghouse Electric Corporation.

Its advantages, they said, are its high efficiency, quiet operation, light weight, extremely low standby losses, and adaptability for automatic operations. This new type converter, together with a vacuum tube oscillator, make it possible to supply the entire field of induction heating and melting with power from electronic equipment.

This new circuit is called the cyclo-inverter. It is derived from the direct-current to alternating-current parallel inverter circuit which has been known and used for years. Three-phase 60 cycle power is converted to single phase power at a higher frequency by means of a single conversion. The cyclo-inverter, they state, eliminates many of the disadvantages inherent in the direct-current to alternating-current parallel inverter without any sacrifice in efficiency.

### *See What They'll Have*

► **MAYBE** it's the English sense of humor, but if you ask an Englishman to "see what the boys in the back room will have," he may answer, "Atomic energy."

London papers carry many stories

Dielectric preheating is a comparatively new industrial tool in the plastics industry, the conference was told. By this means heat is generated within plastics just prior to molding by applying a high frequency electric field. The material, then uniformly softened, can be processed by new techniques suitable for thermo setting plastics.

When full advantage is taken of this new tool, remarkable increases in production of quality parts can be obtained, it was explained by D. E. Watts, G. F. Leland and T. N. Wilcox of General Electric Company. They presented specific suggestions by which the fullest advantage can be taken of a plastic preheat. They also described the electric equipment necessary.

Government allocations for medical and industrial generators emphasize the problem of constant frequency generators, E. Mittlemann, Illinois Tool Works, told the meeting. For small generators, he said, an economical solution can be found by the design of a self-exciting oscillator with high capacity tank circuit, or an oscillator with parallel line tuning to which the load is loosely coupled. In high power industrial generators other solutions must be sought.

these days about the "back-room boys" at Harwell. Harwell is the center of English atomic energy research, and her "back-room boys" are Britain's top nuclear physicists experimenting with atoms.

## Chemical Processes Patented

*The month's grist of patents of interest to the chemically-minded. Twenty-five cents (don't send stamps) will bring you a copy of a patent specification, if ordered by number, from the U.S. Commissioner of Patents, Washington 25, D.C.*

### **Magnesium by Ion Exchange**

► **MAGNESIUM**, the light metal that grew to full industrial stature during the war, can be extracted from salt water containing it by a modification of the ion-exchange process now widely used in softening hard water. The newest adaptation of this process, developed by two Dow Chemical Company research men, M. J. Hunter and W. C. Bauman, is covered by U.S. patent 2,409,861.

The ion-exchanger used in the new process is a carboxylated synthetic resin. Magnesium-containing brine passed through a mass of this in granulated form yields up part of its magnesium, receiving in exchange some of the alkali metal ions (in this case sodium) until an equilibrium point is reached. The magnesium is subsequently washed free of the resin with hydrochloric acid or a chloride solution.

### **Extraction of Pure Selenium**

► **SELENIUM**, the "moon element," is much in demand for photocells, rectifiers and other critical electrical equipment, but is quite costly because of the difficulty of freeing it from impurities. An improved method is cov-

ered by patent 2,409,835, granted to C. W. Clark and E. M. Elkin of Montreal, and G. R. Waitkins of Flemington, N. J.

The impure selenium is first converted to selenium dioxide, in which state it can be separated from the impurities. The oxide is then heated to its evaporation point (603 degrees Fahrenheit) and the vapor permitted to mingle with ammonia gas in a tubular reaction chamber. The reaction results in three end products: water, nitrogen and pure selenium; the latter is caught in a suitable vessel at the bottom of the column. Rights in the patent are assigned to Canadian Copper Refiners, Ltd., of Montreal.

### **Bacteria Produce Syrup**

► **SUGAR SYRUPS** used in food and beverage industries frequently make trouble through their tendency to crystallize. Daniel V. Wadsworth of Manhasset, N. Y., and Mary F. Hughes of Jersey City, N. J., enlist the aid of a bacterial species, *Leuconostoc mesenteroides*, in a syrup-stabilization process on which they have received patent 2,409,816.

Feeding on sugar syrup, the bacteria change part of it into a non-crystallizable molecular mixture termed "dextran," the rest of the sugar remaining mainly in the form of levulose. Heat is then applied, to stop bacterial action. One part of this dextran syrup mixed with five or six parts of thick

sugar syrup will stabilize the whole against crystallization. Patent rights are assigned to Refined Syrups and Sugars, Inc., of Yonkers, N.Y.

### **Noxious Fume Absorbent**

► AN ARGENTINE INVENTOR, Bernardo Baringoltz, proposes to eliminate noxious and dangerous fumes from motor car exhausts through the use of absorbent cartridges containing potassium chlorate, calcium carbide, and the oxides of manganese, iron and copper. He has been granted patent 2,409,825.

### **Image Intensifier**

► NEWEST "see-in-the-dark" device, intended to help humans to see as well as bats and owls, or even better, is termed an "image intensifier" by its inventor, Russell H. Varian of Wadsworth, N.Y., research engineer with the Sperry Gyroscope Company, to which firm he has assigned rights in his patent, No. 2,410,115.

The image intensifier is intended to make clearly visible objects in light too dim for good seeing. It can also be operated on either infra-red or ultraviolet radiations. Basic idea is to focus the visual image, by means of a lens, on a photoelectric grid. Electrical impulses thus produced are amplified as much as necessary, then fed into a suitable image-producing vacuum tube for re-conversion into visible pictures. The device can be used either for direct viewing or in television. Interposition of synchronized rotating disks carrying filters, before both objective lens and viewing screen, can produce colored images if desired.

### **Flame-Spraying With Plastics**

► THE FLAME-SPRAYING method, long used for applying coatings of metals

of low melting-points, has now been adapted for use with thermoplastic resins by two duPont chemists, M. I. Macht and M. M. Renfrew, to whom patent 2,410,225 has been issued. Polyvinyl resins mixed with pigments, the whole in finely powdered form, are thrown from a flame-spraying device. On striking the object to be sprayed they solidify into a uniform, smooth surface.

### **Wax Removed by Chilling**

► WAX is one thing refiners usually want to get out of oil. In a new process, on which patent 2,410,483 was granted to E. M. Dons and O. G. Mauro of Tulsa, this is accomplished by progressive chilling. The wax-containing oil is first heated, then chilled de-waxing solvent is injected into the hot oil stream.

This causes the formation of a cloud of minute wax crystals. Additional increments of de-waxing solvent are injected at progressively lower temperatures, which causes rapid growth of the crystals. Finally they are removed by filtering. Rights in the patent are assigned to the Mid-Continent Petroleum Corporation.

### **Glycerin From Sugar**

► GLYCERIN is produced from sugar by fermentation with ordinary yeasts by Dr. Carl A. Neuberg, New York City, and Irene S. Roberts of Fieldston, N.Y., for patent 2,410,518. Secret is two-fold: very heavy inoculation with yeast culture, and maintenance of relatively high acidity during fermentation.

### **Salt-Treated Cinders**

► WITH WINTER bringing icy roads, the invention on which Bertrand H.

Wait of New Rochelle, N.Y., has received patent 2,410,910 is especially timely. For the chemically treated sand now used to abate slipperiness, he substitutes finely-ground cinders or slag, sprayed while hot with a solution of either common salt or calcium chloride, or both. The porous material adsorbs more of the ice-softening chemicals than sand grains can, the inventor points out, and releases it more evenly to soften the ice and provide the gritty grains for better holding.

### Removing Water From Oil

► TO GET WATER out of crude oil, J. A. Guyer of Bartlesville, Okla., paradoxically adds water. He also adds methane or other gas, under pressure. Release of the pressure brings out the finer water droplets, as well as tiny salt crystals, that make trouble in refining. Rights in the patent, No. 2,410,970, are assigned to the Phillips Petroleum Company.

### Homogenized Glass

► TO MAKE OPTICAL glass of uniform texture, free of troublesome bubbles and striae, Alden J. Deyrup of Westfield, N.J., flows the molten mix through a vessel called a homogenizer, in which streams from various parts

of the mass cross and mingle intimately. Then the mixture is permitted to cool into a solid block. Rights in the patent, No. 2,411,031, are assigned to E. I. duPont de Nemours and Company.

### Helium For Furs

► HELIUM, increasingly used as a "safety gas," finds employment in the fur-treating business in the invention on which patent 2,410,898 was issued to Attilio Pierini of Springfield Gardens, N.Y. At one stage in the dressing of lambskins and other pelts, it is necessary to press the fur against a rapidly rotating, heated drum. It is at this stage that Mr. Pierini introduces an atmosphere of helium or one of the other inert gases.

### By-product Silica Use

► SILICA PARTICLES almost too small to be seen under a microscope, which are formed as a byproduct in metallurgical operations, can be used as modifying agents in cement, James W. Sharp of Los Altos, Calif., has discovered. He has assigned rights in his patent, No. 2,410,954, to the Permanente Cement Company, one of Henry Kaiser's firms.

## On the Back Cover

► "NO TWO ALIKE is the slogan for snow crystals, naturally or artificially produced. A common mistake of artists is to draw them with five or eight points, but all snow crystals show variants of the hexagon pattern. These crystals, and those pictured at the top of page 8 of this issue, were made and photographed in the laboratory of the General Electric Co.

## Alloys For Gas Turbines Meet Fantastic Conditions

# For Hot Winds

*Reprinted from the Industrial Bulletin of Arthur D. Little, Inc.*

► THE GAS TURBINE needs metals that will stand high temperatures, and it is getting them. Focus of today's development in power generation, the gas turbine is a sort of multiple wind-mill driven by the hot gases resulting from combustion. Its operating temperature is inevitably high, and its efficiency increases with higher temperatures. When intensive development of the gas turbine started in this country in 1940, operating temperatures were limited to about 1200° F., which, in a simple cycle, permits an efficiency of 23 per cent; today metals satisfactory up to 1500° and 1600° are available, and efficiency of better than 30 per cent is now possible.

In a gas turbine, the blades meet the most severe conditions and have received the most attention. At operating temperature, a red heat, they are so close to becoming plastic and are whirling so fast that "creep" (elongation because of the centrifugal force) becomes a vital problem, as does also corrosion because of the oxygen remaining in the hot gases.

Evaluation of materials for gas-turbine blades requires a complex balancing of all the factors involved, such as the stress imposed, the amount of creep permissible in view of the turbine's precise construction, the operating temperature, and the life expected. When wartime research started, the Navy set minimum standards calling

for alloys which, operating at 1500°, would have a life of at least 100 hours at a stress of 20,000 pounds per square inch and a creep rate not exceeding one per cent in 100,000 hours at 7000 pounds per square inch. These specifications called for an alloy essentially twice as good as the best which were available at that time.

Surprisingly enough, one of the first good alloys to be applied was one which had long been used in dentistry and surgery. Known under the trademark, "Vitallium," and composed of 65 per cent cobalt, 29 per cent chromium and 6 per cent molybdenum, it is highly resistant to body acids and fluids, notably lactic acid. It also has good corrosion resistance at high temperatures, coupled with high load-carrying capacity, a trait not found in the corrosion-resistant alloys used for electrical heating elements. "Vitallium" was the alloy used for buckets in the aircraft turbosupercharger, which is driven by the hot exhaust and packs air into the aircraft engine.

Recent advances exceed the early Navy specifications by a factor of two from the viewpoint of stress permissible without undue creep, and by a factor of more than fifty as regards rupture life. One alloy, consisting of 20 per cent nickel, 21 chromium, 21 cobalt, and the balance mostly iron, with smaller amounts of a number of other elements, will endure a stress of



15,000 pounds per square inch at 1500° without excessive creep. Modified "Vitalium" compositions are estimated to be capable of lasting well over 7000 hours at the specified stress and temperature.

Since these and many others of the best high-temperature alloys cannot be forged or machined, they must be formed by the precision casting method, taken over from the dental and jewelry trades, and widely used industrially during the war. An alloy of 60 per cent chromium, 25 molybdenum, and 15 iron is even stronger at 1600° than some of the above compositions at 1500°, but is too difficult to produce commercially at present because of its high melting point. Forgeable alloys meeting somewhat less stringent requirements as to rupture life and creep are available for operation at 1500° and can be used for the turbine rotors as well as the blades.

The cobalt-base alloys are stronger for short-time performance, whereas those containing approximately equal amounts of nickel, chromium, cobalt and iron are better for long-time use, that is, greater than 10,000 hours. All the alloys require at least 20 per cent chromium for protection against corrosion and oxidation at high temperatures.

Wartime development has for the present eliminated metallurgical problems as the bottleneck in gas turbine development; design and combustion problems are now the limiting factors. Operation of 1500° and 1600° has been indicated as feasible and tests show present alloys to be promising even up to 1800° if stresses are reduced. Efficiencies up to 30 per cent have been demonstrated and promise to make the gas turbine engine an important contender in many large-scale power installations.

## *Boron Can Replace Molybdenum*

► VALUABLE new information on the use of boron partially to replace molybdenum in hardening steels has resulted from a wartime study now available to the public.

The testing was carried out at the Battelle Memorial Institute, Columbus, Ohio, under the sponsorship of the National Defense Research Committee by M. C. Udy, and P. C. Rosenthal. A report prepared by these two scientists is available from the Office of Technical Services, U.S. Department of Commerce.

One hundred boron-treated steels

were tested. Nickel-chromium-molybdenum and manganese-molybdenum base steels were used. From the standpoint of hardenability best results were obtained with additions of .0015% to .002% boron, the researchers found. The boron addition had no apparent adverse effect on the notch-bar toughness at temperatures down to 80 degrees below zero Fahrenheit.

Boron can be used to replace half the molybdenum in aluminum-killed steels of certain compositions, the report states.

**Emulsion Chemist Must Be  
Smarter Than His Chemicals**

## Practical Emulsion Manufacture

A Chapter from the book *EMULSION TECHNOLOGY, THEORETICAL AND APPLIED*, 2nd edition, edited by H. Bennett, Chemical Publishing Co., Brooklyn, N. Y. 1946.

by Miss R. M. K. COBB

*Chemist in Charge of Research Laboratory, Lowe Paper Co.*

► TWO OR MORE liquids may be virtually insoluble in each other and yet may be formed into a stable mixture by proper dispersion. In the classification of colloidal systems, liquid-in-liquid dispersion systems are known as emulsions. By common consent, the term is extended to cover dispersions of molten materials such as wax and resin in liquids, even though, on cooling, the non-polar phase is a solid.

In nature, oil-and-water dispersions are so well and widely distributed that it may seem as if emulsion formation is a most casual performance. But in reality, the production of a satisfactory commercial emulsion calls for an exacting blend of scientific knowledge, practical skill, and intuition, commonly known as a "flair." To master emulsion manufacture, it often seems, that one must be smarter than the emulsion, get up earlier in the morning, work harder, and study more.

According to Gibbs' classical definition, an emulsion is at equilibrium only when broken. Thus, an industrial emulsion system possesses an immense amount of potential energy. Stored in a 50 gallon drum, or a 1,000 gallon tank, it has nothing else to do with that energy all day and all night but to coalesce, cream, and break into

its original components. Working out formulae, for permanently usable emulsion products, presents a problem different, therefore, from that of the scientist in the laboratory. For the scientist forms his emulsion, measures, tests, and pours it down the sink with satisfaction, often within the space of a single hour or day. . . .

### General Principles

After deciding upon the emulsion characteristics desired, that is, whether the droplets should be of oil or water, fine or coarse, the emulsion thin or viscous, and knowing the density of the oil to be emulsified, the problem of emulsification comes to the stage where conditions of formation are to be considered. Here is a kettle of oil or molten wax or resin; there is a kettle of water; what must be done to make them into an emulsion of the desired stability?

Thomas<sup>1</sup> states that to disperse one liquid in another, in the form of an emulsion, requires doing an amount of work upon the system equal to the product of the interfacial tension multiplied by the increase in surface.

$$W = \gamma \Delta S \quad (1)$$

Where

$W$  = work in ergs/cm<sup>2</sup>

$\gamma$  = interfacial tension of oil-water in ergs/cm<sup>2</sup>

$\Delta S$  = increase in surface of dispersed phase due to formation of emulsion droplets.  
 $S$  is in  $\text{cm}^2$

The original surface of the dispersed phase may be considered negligible in comparison with the surface of that dispersed phase extended in the form of droplets. Thus, the increase in surface  $S$  is related to the total volume of the emulsion droplets, and the diameter of each droplet, as

$$\Delta S = 6V/d \quad (2)$$

Where

$V$  = total volume of emulsified internal phase in cc

$d$  = diameter of emulsified droplets in cm

Substituting in (1)

$$W = 6\gamma V/d \quad (3)$$

That is, to emulsify a given amount of oil in water, a definite amount of work has to be done—a fact which the layman intuitively acknowledges when he shakes oil-in-water medicines before taking.

Equation (3) states that the forming of an emulsion is facilitated when the interfacial tension of the water against the oil is low.

Term  $d$  in the denominator of equation (3) indicates that the smaller the particle size of the emulsion, the more work must be done to get that fine-sized droplet.

### Role of Emulsifying Agent

To reduce the amount of energy required for emulsification and yet obtain small droplets, it is evident from (3) that the interfacial tension between water and oil must be lowered to a marked degree. This calls for the presence of a third component of the

emulsion system — the emulsifying agent.

Without the presence of an emulsifying agent, emulsions of the oil-in-water type can be prepared only by intense agitation and, according to Lewis<sup>2</sup>, only up to a maximum concentration of 2%. To prepare a more concentrated stable emulsion, the presence of an emulsifying agent is essential.

Workers in the field of emulsions have indicated that an emulsifying agent should have all or most of the following characteristics:

1. Reduce the interfacial tension of the oil against water to 10 dynes or less for emulsions which are to be made with a colloid mill or homogenizer<sup>3</sup>.
2. Reduce the interfacial tension of oil against water to 1 dyne or less for emulsions to be made spontaneously, i.e., by mere paddling, without violent mechanical agitation.<sup>4</sup>
3. Be more soluble in the outer than the inner phase of the emulsion, so that it will be readily available for adsorption at the membrane around the emulsion droplets. If the oil is to be in droplets, and water the outer phase, the emulsifying agent should be more water-soluble. If the water is to be in dispersed droplets, and oil the outer phase, the emulsifying agent should be more oil soluble<sup>5</sup>.
4. Adsorb quickly around the emulsified droplets in a condensed, viscous, rigid, non-adherent film which will not thin out when two droplets collide, hence will not permit coagulation or coalescence of the emulsion particles<sup>6</sup>.

5. Impart appreciable viscosity to the emulsion itself<sup>7</sup>.

6. Impart an electrokinetic potential difference between the phases of .03-.06 volts, which, it seems, is most easily obtainable in slightly alkaline solution<sup>8</sup>.

7. Be of such specifically designed molecular structure that the non-polar end of the molecule may be persuaded to fit into the molecular structure of the oily material, whereas the polar end of the emulsifying agent has strong affinity for water<sup>9</sup>.

8. Emulsify at least four parts of material per unit of emulsifying agent.

9. Be relatively inexpensive; add not more than two to five cents to the cost per pound of the solids in the emulsion.

10. Impart to the dried film the desired soluble or insoluble properties.

### **The Proper Emulsifier**

The quickest way to solve the problem of emulsifying any given oil, wax, or resin is to state the problem to the manufacturers of emulsifying agents. In this way, one may secure a material specifically designed and tailored to emulsify the oil in question. The manufacturer will also supply an exact or approximate emulsion formula, including the average particle size obtainable and the stability of the emulsion.

If an economical solution of the problem is not obtained by such inquiry, it will be necessary to make a systematic survey of the situation.

If the oil is to be dispersed in water, one of the most effective ways of reducing the interfacial tension of the oil, to the point where it is really solu-

ble in water, is to sulphonate it, and convert the sulphonic group to the sodium salt. The addition of the  $\text{SO}_3\text{Na}$  radical to the oil provides the water-soluble hook which reduces the interfacial tension to zero, and makes the oils water-soluble. Sulphonation is commonly used to disperse glycerides such as castor, cottonseed, corn, fish, lard, linseed, neatsfoot, olive, soybean, and sperm oils. Unfortunately, sulphonation often modifies the oil, to such extent, that its desirable properties are unduly altered; an effect which cannot be minimized even by careful control of the sulphonating process.

Saturated organic materials such as waxes and some oils have no available double bond and resist sulphonation. Waxes, due to their melting points, present the further difficulty of requiring a high sulphonating temperature, at which they are apt to char, during the sulphonating process. When an oil or wax is of such nature that the water-soluble group cannot be built into the molecule itself by sulphonation or other chemical means, an external emulsifying agent must be employed.

### **Emulsifying Agents**

Though the list of emulsifying agents is almost endless, many of those used in commercial emulsions may be found in the following list:

Agar agar  
Albumen  
Alginate  
Aluminum oleate, resinate, stearate  
Amino-methyl-propanol  
Ammonium laurate, linoleate, oleate, stearate  
Bentonite  
Bile

Calcium oleate, stearate  
 Carbon black  
 Cascinates  
 Cholesterol  
 Clay  
 Copper oleate, resinate  
 Dextrin  
 Diethylene glycol oleate, palmitate, stearate  
 Egg Yolk  
 Ethylene glycol laurate, oleate, ricinoleate, stearate  
 Fuller's earth  
 Gelatin  
 Gliadin  
 Glue  
 Glyceryl laurate, myristate, oleate, palmitate  
 Gum arabic  
 Gum tragacanth  
 Hemoglobin  
 Irish moss  
 Lanolin  
 Lecithin  
 Lignin  
 Montan wax  
 Morpholine oleate, stearate  
 Pectin  
 Potassium linoleate, oleate, resinate, stearate  
 Proteins  
 Quaternary ammonium compounds  
 Resins  
 Saponin  
 Sodium linoleate, myristate, resinate, stearate  
 Sodium salts of sulphonic acids  
 Starch  
 Sulphated alcohols  
 Sulphonated castor, corn, fish, mineral, neatsfoot, olive, soybean, and sperm oils

In general, monovalent soaps and hydrophilic colloids make oil-in-water

emulsions. Polyvalent soaps and hydrophobic colloids make water-in-oil emulsions. Some materials, such as sodium stearate, yield either type, depending upon the quantity used, and the method of emulsion manufacture. . . .

### Emulsifying Methods

Having obtained a preliminary idea of the oil and water phases of the emulsion, including the likeliest emulsifying agents and the interfacial tensions to be overcome, the best of the emulsifying methods must be selected by trial and test.

Emulsions may be formed in a great many different ways, all of which are variants of the following:

A. Brute force.

B. Persuasion.

1. The emulsifying agent may be dissolved in the water, and the oil added, with considerable agitation.

Method 1. makes oil-in-water emulsions directly. If a water-in-oil emulsion is made by this method, the oil should be added to the oil-in-water emulsion until inversion occurs.

2. The emulsifying agent may be dissolved in the oil. The emulsion may then be formed in two ways: (a) By adding the mixture directly to water, in which case, an oil-in-water emulsion forms spontaneously. (b) By adding water directly to the mixture, in which case, a water-in-oil emulsion is first formed. To form an oil-in water emulsion by method (2b), it is necessary to invert the emulsion, by addition of more water than can be held, in water-in-oil form.

3. The fatty acid part of the emulsifying agent may be dissolved in the

oil, and the alkaline part in the water. In this case, the formation of nascent soap, at the moment of mixing the two phases, brings about emulsification, either oil-in-water, or water-in-oil.

4. The oil and water may be added alternately, in several steps, to the emulsifying agent, forming either water-in-oil or oil-in-water emulsions.

1. Thomas, A. W., *J. Am. Leather Chem. Assn.* 22, 171 (1927).

2. Lewis, *Kolloid-Zeitschr.* 4, 211 (1909).
3. Harkins, W. D. and Zolman, H., *J. Am. Chem. Soc.* 48, 69 (1926).
4. Cobb, R. M., Chamberlin, D. S. and Dombrow, E. A., *Paper Trade J.* 97, 35 (Sept. 7, 1933).
5. Bancroft, W. D. and Tucker, J. *Phys. Chem.* 31, 1681 (1927).
6. Newman, J., *Phys. Chem.* 18, 34, 45 (1914); Serrallach, Jones & Owen, *Ind. Eng. Chem.* 25, 816 (1933).
7. Bancroft, W. D., *J. Phys. Chem.* 16, 179, 233, 746 (1912); Corran, J. W., *Tech. Aspects of Emulsions* (Chemical Publishing Co., 1936), 100.
8. Ellis, R., *Trans. Far. Soc.* 9, 14 (1913); Steik, K., *Am. Dyestuff Repr.* 25, 429 (1936).
9. Finkle, Draper & Hildebrand, *J. Am. Chem. Soc.* 45, 2780 (1923).

## Study "Pure" Science; Young Chemists Advised

► STUDY "PURE" science; don't go in too early for immediate practical problems. This advice was offered at the Science Talent Institute by Dr. Roger Adams, University of Illinois organic chemist, during the war with the Office of Scientific Research and Development.

A broad fundamental training in science, carried on at least as far as a doctor's degree, is better preparation for a research career than any kind of early specialization, Dr. Adams said.

Choosing illustrations from his own field of chemistry, he called attention to certain "lucky breaks" in the development of such sensational successes as penicillin and the sulfa drugs. The chemists who saw these breaks and took advantage of them were men who were prepared by thorough general training; they were able to follow the implications of apparently trifling facts which hundreds of more narrowly trained, less imaginative men had also

doubtless noticed but had passed by as having no practical significance. Thus "pure" science had turned out to be more practical in the long run.

Another important factor in recent chemical progress which Dr. Adams pointed out to the hopeful chemists among his listeners is the cooperative nature of practically all major discoveries. The widely accepted notion of a chemist working alone in a cellar laboratory and suddenly popping out, shouting "Eureka!" is quite erroneous, he declared. Actually, every great discovery is the product of several severely disciplined brains, sometimes consciously working together in the same laboratory, sometimes working independently and in succession. In such important tasks as the analysis of quinine and cocaine, and the eventual synthetic production of improvements on them, as much as 50 or 75 years have elapsed between the first steps and the last.

Forty-watt fluorescent lamp recently developed does not require a starter and operates on a special type of instant-starting ballast.

## Chemical Things To Do

# Make Pocket Magic Lantern

by JOSEPH H. KRAUS

➤ A MAGIC LANTERN small enough to fit into your pocket and useful in lecturing to or entertaining a few people at a time can be built by the junior scientist in one evening. A used two-cell flashlight in good working condition provides the illumination, while the lens may be a small reading glass. Slides may be made from short lengths of positive movie film, prints on film from your negatives, or drawings done directly with pen and ink on clear film.

The sharpness of the projected picture will depend largely upon the quality of the lens you use for this projector. Use only a lens through which you can see a clear picture. A double convex lens, with a focal length of  $2\frac{1}{2}$  to 4 inches will work, but a plano-convex lens will probably be better. If you are not familiar with the names of these lenses, their shape will help you identify them. A double convex lens is curved outward on both sides while the plano-convex is flat on one side and rounded on the other.

### Use a Cheap Lens

If you do not have handy a reading glass you may use a magnifying lens, or a lens from a toy telescope. Cheap discarded lenses are also beginning to appear on the market.

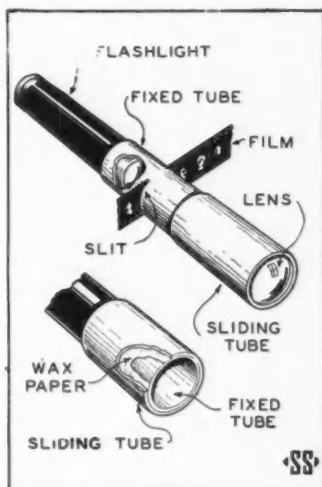
To find the focal length of your lens, let the rays of the sun or a light shine through your lens and move the lens back and forth until the rays

are concentrated in a point of light. Now measure with a ruler the distance between the lens and the paper. This will give you a close approximation of the focal length in inches.

If you have two lenses of about the same quality from which you can choose, select the one with a diameter slightly larger than the flashlight you intend to use. This will make it easier for you to handle later.

### Make Tubes

To adjust the focus, you are going to want to mount your lens in a combination of tubes that can slide one within the other. To determine the length of your focusing tubes, make this simple test. Light a short, stubby



candle and set it near the edge of your work table. Turn out all the other sources of light in the room. Hold the lens vertical and about twice its focal distance from the candle in such a position that the image of the candle will appear, upside down, on the wall.

Vary the distance between the wall and the lens as well as the distance between lens and candle until you get a clear-cut image on the wall of a size that will show up nicely. The distance between the lens and candle is about the right length for each of the two tubes.

### Fit Snugly

Make your tubes from two strips of stiff wrapping paper. The width of the paper should be the length of the tubes; the strips should be several feet in length. Cover one side of the paper with flour and water paste or library paste.

Roll the paper up to form a tube with the lens end of the flashlight tightly enclosed in one end of the tube. Make sure that you roll it up

straight. Wrap it around and around until you form a tube about one-eighth of an inch thick. Cover this tube with a single layer of waxed paper, then make a larger tube by wrapping a second strip of paper around the outside. When dry, separate the two tubes, and throw away the waxed paper. Your two tubes now fit together snugly and yet they will slide easily.

Attach your curved lens to the end of your tube with the larger diameter, the outer one. If the lens is too large, let it extend evenly on all sides. If it is slightly smaller, make a cardboard washer to fit and attach the lens to the edge of the hole in the washer. The lens may be cemented in place with model airplane cement, or it can be held in place with a piece of gummed paper.

When finished, make a knife or saw cut on each side of the tube about a half inch from the lens, so the film with the pictures you wish to show your audience can be slipped through.

## Answers to Chem Quiz on Page 25

1. The metals known to the ancients were (1) gold, (2) silver, (3) copper, (4) tin, (5) iron. (6) lead, (7) mercury.

2. The elements not yet discovered are atomic numbers 43, 61, 85 and 87.

3. The following metals have been made by transmutation: 93—Nep-

tunium, 94—Plutonium, 95—Americium, 96—Curium.

4. Arsenic was discovered during the Middle Ages.

5. Every member of the human race discovers oxygen and nitrogen with his first breath!

Anhydrous alcohol, used in peacetimes for admixture with gasoline as a motorcar fuel, is now attracting world-wide attention as a substitute for gasoline because it can be made almost anywhere from almost any carbohydrate.



## Insulin Helps "Lost Weekend" Patients

► ACUTE ALCOHOLICS, treated with insulin, can be lured away from drink twice as fast and with greater ease and comfort than by the usual method of gradually withdrawing alcohol from the diet, Dr. Etem G. Vassaf and Dr. Volta R. Hall, of the Ring Sanatorium and Hospital, Arlington, Mass., have found.

Small doses of insulin were given two or three times daily before meals to 43 patients whose "lost weekends" varied from two days to three months. The patients, 29 of whom were men and 14 women, were forced to drink plenty of fruit juices, in a diet of high-calorie and high vitamin foods. Those who showed signs of tremors, excessive sweating, confusion, or disorientation, were also given injections of vitamin B<sub>1</sub>.

Of the patients, 44% required no alcohol after receiving insulin, while in a group of 564 patients who were not given insulin, only 14% could give up whisky at once. The average withdrawal period for the insulin patients was one day, slightly less than half the

2.2 days required by the average alcoholic receiving no insulin.

Nursing and medical staffs agreed that the patients receiving insulin were more contented and cooperative, less restless and fault-finding, and less insistent in their demands for alcohol than were the control patients.

Scientists have long known that the burning of alcohol and its consequent disappearance from the body may be speeded by the catalytic action of simultaneous oxidation or burning of sugar. Drunks, completely "out" in a serious alcoholic coma, have been sobered up in two hours or less and able to walk alone within four hours by injection of both sugar and insulin.

Insulin, administered alone, will speed up the oxidation of blood sugar, otherwise dormant when alcohol is present, and this, in turn, speeds up the elimination of the alcohol itself.

Drs. Vassaf and Hall, reporting their studies to the New England Journal of Medicine, suggest greater future use of insulin in treatment of acute alcoholism.

## Anti-Anemia Vitamin Isolated

► CRYSTALS of a pure chemical which is a form of an anti-anemia vitamin have been isolated for the first time by scientists at the research laboratories of Parke, Davis and Company in Detroit.

This vitamin chemical is known only by the technical name of vitamin Bc conjugate. Its isolation is announced in a recent issue of *Science*. Scientists reporting the work are Drs. J. J. Pfiff-

ner, D. G. Calkins, B. L. O'Dell, E. S. Bloom, R. A. Brown, C. J. Campbell, O. D. Bird.

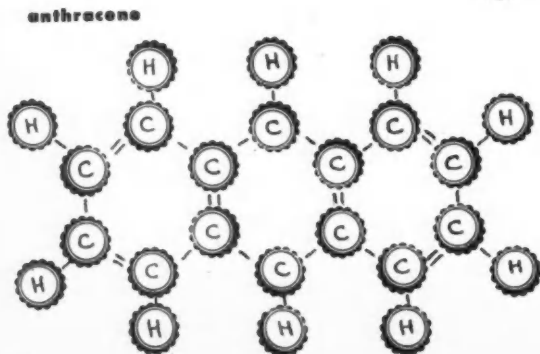
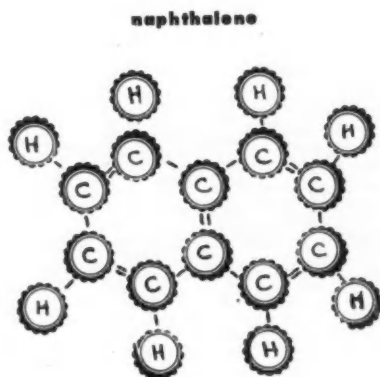
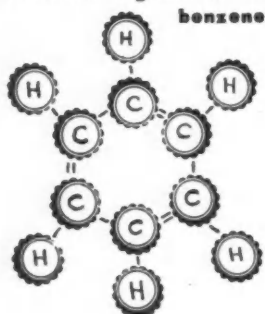
The vitamin is related to another vitamin called folic acid. Synthesis of the latter by scientists at Lederle Laboratories, Pearl River, N. Y., was announced just a few weeks ago. This vitamin apparently exists in a number of chemical forms in different substances, such as liver and yeast.

**Aliphatic Compounds Are Chains**  
**Aromatic Compounds Are Rings**

## Benzene and its Relatives

► CARBON's enthusiasm for combining with other carbon atoms leads to ring formation in molecular structure, as well as to chains. A particularly stable molecule is the well-known benzene ring, consisting of six carbon atoms. The exact arrangement of the attrac-

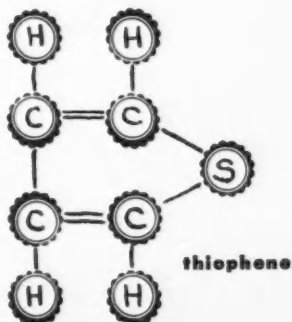
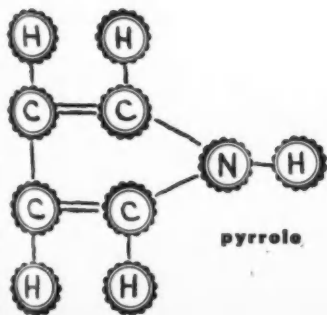
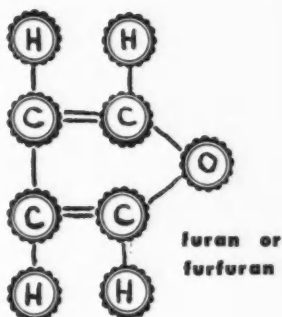
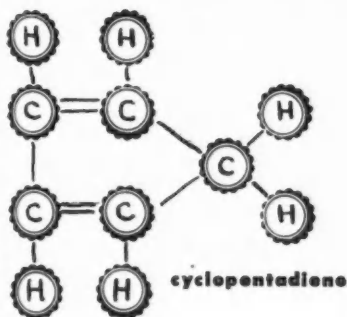
tive forces holding these six atoms was a puzzle for a long time, until the German chemist, Kekulé, worked out the convention of the alternating double and single bonds. These allow a satisfactory statement in terms of structural formulas of the reactions



which occur. Therefore the benzene ring is the standard picture of the molecule, whether or not the molecule would actually look like its picture were it magnified enough to be seen.

The benzene ring is by no means unique. Many types of organic compounds have the ring structure. There are rings of three and more carbon atoms. There are also series of compounds in which atoms other than carbon join in ring formation. The

latter types are grouped under the name "hetero-cyclic" compounds. Some characteristic types of ring compounds are diagrammed here. Each of these molecules is to be looked upon as merely the beginning of a long series of compounds, in which each of the atoms takes part in the formation of characteristic organic compounds. Hydrogen which is joined to a carbon atom may be replaced by methyl, ethyl or other reacting groups; by hydroxyl, oxygen or carboxyl radi-



cals; by amino groups and their derivatives; by atoms of the halogen elements or by the more reactive metals. And each of the resulting compounds is a definite chemical, with its own melting and boiling points, crystalline structure or conspicuous lack of it, solubility, color, odor, taste, etc., all

of which are eventually catalogued somewhere in a reference book, so that the next chemist who makes that compound can test his material by comparison with data furnished by his predecessors long ago or far away. Organic chemistry is a voluminous subject.

## Freon Kills Gasoline Fires

► THE FREON chemical compounds that are used in household refrigerators and in air-cooling systems now have a new job. They are found to be more effective in extinguishing gasoline fires than the long-used carbon dioxide and other inert gases.

Freon is well-known to soldiers. It is the carrier for DDT, compressed into the aerosol bomb, which when released made an effective spray to kill mosquitoes and other insect pests. The freons are harmless to man, being non-toxic, non-combustible, non-explosive and non-irritant.

The use of freons to extinguish gasoline fires is recommended by the U.S. Bureau of Mines because of their effectiveness determined by a study of six inert gases and their effects on three different types of gasoline. The study was made by Bureau scientists and others from the Mine Safety Appliances Company.

Among the six gases tested, freon 11 was found to be the most effective flame-quenching agent. Freon 12, freon 21, carbon dioxide, automobile-exhaust gas, and nitrogen were next best in the order named.

Rubber stamps and rubber printing plates made of synthetic rubber are said to be better than those made of the natural product.

Gasoline is one of the chief causes of costly fires and explosions because it is used by industry, the Bureau states, in a greater quantity and a wider range of applications than any other combustible liquid. Gasoline fires in or about mines are not uncommon.

The freons are a series of compounds containing the same elements but in different proportions. They are made by introducing fluorine into chlorine derivatives of methane gas. Their chemical names indicate that they contain both chlorine and fluorine.

Freon 11 is trichloromonofluoromethane, a long word but easily understood when divided into syllables: tri-chloro-mono-fluoro-methane. Freon 12 is dichlorodifluoromethane, and freon 21 is dichloromonofluoromethane. Freon 21 is probably the one most commonly used in refrigerating and air-cooling systems. Freon 11, the best flame-quenching agent among the six inert gases tested, is used in centrifugal compressors feasible only for large refrigerating or air-cooling units.

## Famine As War Weapon With Plant-Killing Chemicals

# Chemicals Can Blight Crops

by DR. FRANK THONE

► FAMINE will join with atomic bombs and man-made pestilence to make World War III an apocalyptic horror, if mankind becomes so mad as to start fighting again. And while it may be possible to protect factories, and even dwellings against atom bombs by hiding them underground, famine cannot be escaped in that way because crops have to be up on the surface in the sunlight.

Visions of famine as a weapon are proved to be realizable at will even now, by publication of details of biological warfare experiments carried on in the deepest of wartime secrecy at Camp Detrick, Md. Dr. A. J. Norman of Iowa State College, who was in general charge of the work, joined with a group of colleagues in presenting results of the researches in the *Botanical Gazette*, University of Chicago.

The chemicals that can be used to spread famine by ruining an enemy's crops are complex organic compounds. One of them has already come into general use as a weed-killer under the convenience-designation of 2,4-D. The Camp Detrick experimenters tested the effects of about 1,100 of these, and found that some of them are even more toxic to plants than their prototype.

It would not be necessary to kill all the plants in a field to make the crop a failure, the experiments showed. One

drop of a very dilute solution of some of the chemicals falling on a leaf would cause the stem to twist and often also to develop lumpy, tumor-like galls. The plant might survive, but it would live on only as a twisted, stunted cripple, unable to produce its full quota of food. Spraying tops can seriously affect underground parts, too; in some of the experiments potato tubers were badly damaged by chemicals on the vines above them.

Contact with the chemical does not need to be prolonged to work a great deal of mischief. In some cases the plant begins to become sick and crippled in as little time as an hour after the fatal drop has fallen on a leaf. And if the chemical is dissolved in oil instead of water it will stick to the leaf and do its poisonous work, even if a heavy rain comes up immediately after the oil drop has fallen and stuck.

A considerable number of food plants were used in the experiments—enough to indicate pretty thoroughly that no crop can be considered safe. Among them were corn, wheat, barley, oats, potatoes, tomatoes, soybeans, kidney beans, cabbages and turnips. Had either Germany or Japan launched a biological warfare drive against us (and it was known that both had ideas of doing so) a counter-attack against their crops would have followed very quickly.

Now that these compounds are not needed for the grim business of war

they can be used for the purposes of peace. One of them, 2,4-D, is already on the job as a weed killer, where others may presently join it. Others may be employed in lighter doses to stimulate plants rather than kill them. Among possible uses along this line are increasing the yield of apples, preventing the premature dropping of fruit, and killing potato vines before harvesting the tubers.

The reasearch program carried out at Camp Detrick was first suggested

by Prof. E. J. Kraus of the University of Chicago, and some of the first work was done in his laboratory there, just across the street from the site of the first nuclear-energy pile. Some of the later experiments were also carried out at the U. S. Department of Agriculture's experiment station at Beltsville, Md. A considerable number of the compounds used, which had never previously been made, were synthesized by Prof. Melvin S. Newman at Ohio State University.

## *New Jobs for Chemists*

► NEW JOBS in the chemical industries are predictable from economic studies, according to Dr. L. W. Bass, Director of Chemical Research of Air Reduction Company and U. S. Industrial Chemicals, Inc., New York.

A new technical job is created in the plastics and synthetic resin field for each 200 tons additional manufacturing capacity. In the petroleum field, each increase of 200,000 barrels in the amount of crude going to the refinery means another position has been opened for some technically trained person, not including the jobs opened at the same time for unskilled help.

"Salaries of chemical engineers show a wide spread between high and low figures, a characteristic of professional earnings," Dr. Bass went on to say, and salaries also increase with length of experience."

"In 1943, 10% of the chemical en-

gineers, 4.5 years after graduation, were earning more than \$364 a month and 90% were receiving more than \$217, the median salary being \$275," Dr. Bass reported. "In that same year, 25% of the engineers with 28.5 years of experience were paid more than \$902 a month, 75% were earning more than \$444, and the median salary for this group was \$629 a month.

"Eighty-three percent of the chemical engineers are employed by private firms. The Federal government employs 5.6% and the State governments 2.4%. The oil industry employs 15.7% of the chemical engineers. This field is one of the major sources of employment for the profession.

"There will be expanding opportunities in other industries, such as foods, textiles, and leather, which now do not have many chemical engineers. The versatility of the profession is a valuable asset in such lines of manufacture."

Birds will not dig up and eat newly sowed seed if it has been treated before planting with an unpalatable compound in the anthraquinone series.

## Spectra Play Increasing Part In Identifying New Elements

# Last of the Rare Earths

### A Classic of Chemistry

► THE PAST CENTURY and a half has seen the discovery and separation of the rare earth elements. When the first of them was found by Gadolin in the rare black mineral from Ytterby, chemists were not sure whether the metal or its earthy oxide is the primary form of the element. The development of analytical methods grew out of attempts to get a 100% analysis of ores and rocks.

Fractional precipitation and crystallization was devised to separate the very similar elements of the rare earth group, and spectroscopic analysis was more and more relied upon to determine the purity of the fractions. Spectrum lines have been mapped, and the lines belonging to various elements sorted out.

Much has been learned about the

structure of the elemental atoms from spectrum lines, which bring us messages direct from the interior of those minute microcosms. This new information now tells us that the identification of element 61 as illinium, announced in 1926, is in error. Radioactive isotopes of element 61 are known, which do not correspond to the description of illinium, but the complete announcement of No. 61 is yet to be made.

The entire history of the rare earth elements is a series of approximations. Evidence is gathered, sifted, tentative separations are made, and each step leads on to more exact knowledge.

Announcements of other elements in Group III will appear as the next Classic of Chemistry.

## Dysprosium

HOLMIUM (OR EARTH X ACCORDING TO M. SORET) CONTAINS AT LEAST TWO METALLIC RADICALS. Note by M. Lecoq de Boisbaudran. In *Comptes Rendus V. 102 p. 1003, 1886. Translated for CHEMISTRY by Helen M. Davis.*

M. Lecoq de Boisbaudran asked for the opening of a sealed communication which he had deposited on April 27, 1886.

This communication, recorded under the number 4044, was opened during the meeting by the perpetual secretary; it contained the following note:—

► IN OCTOBER 1878 (*Comptes Rendus LXXXVII, p. 559*), M. Delafontaine announced a new earth, *philippine*, and attributed to it the strong absorption band placed at about 164.25 of my scale ( $\lambda = 451.4$ ), a band which was included in the spectrum of the old erbene.

At the beginning of 1880 (*Comptes Rendus XC, p. 221*), M. Delafontaine recognized that the band 451.5 is due to the same substance as the other lines considered by M. Soret and by M. Clève as characteristic of holmium. M. Delafontaine added that this hol-

mium was identical with his philippium: he stated in particular that it was not possible to admit that the band 451.5 was proved due to the same entity as bands 640.4 and 536.3.

Finally, in August 1880 (*Comptes Rendus XCI*, p. 378), and September 1880 (*Archives des Sciences physiques et naturelles*, p. 80; *Genève, 15 septembre 1880*), M. Soret replied that M. Delafontaine had given up his old idea of the identity of holmium and philippium, after having stated that this last substance does not give a visible absorption spectrum, and that the bands which were at first attributed to it really belong to holmium.

There result from this short historical summary these questions: — 1st. Whether M. Delafontaine's philippine has no visible absorption spectrum. 2nd. Whether all the lines in the following table (compiled by M. Soret) are actually regarded as belonging to a single element, holmium.

*Visible spectrum of Earth X, or holmium, after M. Soret.*

804	? Very strong
753	Weak
640.4	} Very characteristic
536.3	
485.5	
474.5	Very weak and nebulous
453 to 449	
430	Doubtful
414.5	
389 to 387	

I have succeeded meanwhile, by means of many hundred fractionations by means of ammonia and potassium

sulfate, in obtaining, in one part, earths showing more strongly 753 and 451.5 in the complete absence of 640.4 and 536.3 and, in the other part, earths giving 753 and 451.5 much more feebly, while 640.4 and 536.3 appear very clearly.

The oxide hitherto called *holmine* is therefore not homogeneous and is composed of at least two radicals. As the lines 640.4 and 536.3 are pre-eminently those which served M. Soret and M. Clève to discover the presence of a new element in the old erbine, I propose to preserve the name *holmium* for the element giving rise to those lines and to give the name *dysprosium*<sup>1</sup> (symbol Dy) to the metal which gives the lines 753 and 451.5.

A study still has to be made to assure ourselves that 640.4 and 536.3 are really due to the same earth, and the same for 753 and 451.5<sup>2</sup>.

As for the other bands contained in the above table, it will be necessary to classify them and to see if it is possible to divide all of them between the spectra of Ho and Dy.

In fractionation with potassium sulfate and alcohol, the first precipitates contain mostly terbine, then come dysprosine, holmine and then erbine.

<sup>1</sup> From the Greek, meaning: difficult to approach.

<sup>2</sup> M. Soret marks 753 as weak; I find it rather strong, with the products which do not give 640.4 or 536.3, whereas it is almost nil in the case where 640.4 and 536.3 are quite distinct and where 451.5 still appears clearly, although greatly attenuated. Under the conditions of my observations, the bands 753 and 451.5 seem thus to follow the same variations in intensity.



## Europium

ON A NEW ELEMENT, EUROPIUM.  
*Note by Eugene Demarcay, presented by Henri Moissan. In Comptes Rendus, Vol. 132, p. 1484. June 17, 1901.*

► IN 1885 M. CROOKES (Phil. Trans. v. CLXXVI, p. 691), in his beautiful researches on electric fluorescence in a vacuum, reported a band which he attributed to samarium and which, because of its disappearance in the presence of calcium and of some other peculiarities, he called the *anomalous line*. Later he distinguished it with a number of other bands as characterising apparently some special meta-element. He called *S delta* the hypothetical meta-element corresponding to the anomalous line. M. Lecoq de Boisbaudran, in the course of his important researches on phosphorescence, confirmed the announcements of M. Crookes upon the anomalous line.

In 1892, M de Boisbaudran described a spectrum of three brilliant blue lines, discovered in the spark spectrum of samarium. These three lines could be strengthened by suitable fractionation. From this he concluded that they correspond to a particular element *Z epsilon*. At the same time he turned his attention to a particular band of the reversal spectrum of samarium which seemed to correspond to the anomalous line and was considerably strengthened in nitric acid solution. M. de Boisbaudran, without stopping for entirely precise conclusions, was inclined to believe it characteristic of a particular element *Z zeta*.

In 1896, I announced the presence

of an element intermediate between gadolinium and samarium, characterised by various strong violet and ultra-violet lines. In 1900, I showed that this new element was identical with *Z epsilon* of M. Lecoq de Boisbaudran, that it was similar to the material to which the anomalous line of M. Crookes was due, the reversal line *Z zeta*, various other reversal lines not yet described, and, further, a special absorption spectrum unknown until that time. I added that it had not been possible for me to continue the fractionation long enough to affirm positively that all these properties correspond to the same substance. Since then, I have been able, following a considerable number of fractionations of magnesium nitrate, to accumulate a greater quantity of this scarcely abundant element, to fractionate it in turn and to report finally that these different characteristics: line spectrum, spectrum of reversal, absorption, electric fluorescence of the sulphate in vacuum (anomalous line) with calcium or gadolinium sulphate, accompany one another very constantly, remain sensible proportional and that they evidently characterise the same element.

The apparently contradictory results of MM. Crookes and Boisbaudran are due, I think, to the varying proportion of *Sigma—Z epsilon* contained in their material and to the fact that calcium and gadolinium reinforce the spectrum of samarium more than of the other.

I propose for the new element the name *europium*, with the symbol Eu = 151 (approximately).

## Hints for Your Lab

### Heating Devices

► We readers of CHEMISTRY that constitute the Amateur Chemists are always interested in any Chem Lab hints that can help us in the pursuit of our hobby. In particular, any ingenious new method for constructing laboratory equipment at low cost is most welcome, for few non-professionals can afford to equip their laboratories with manufactured apparatus.

I am thankful that you have found time and space to devote to our well being. Perhaps some of my enclosed ideas will be worth considering.

Of course the Bunsen burner is a most useful device, but even it has its short-comings. Various other apparatus for high or exactly regulated temperatures can be constructed with the help of the nichrome wire heating

coils that are sold at most hardware stores.

Figure 1 shows a cut-away view of a constant temperature oven for chemical and biological experiments. The temperature can be set and regulated by adjusting the action of the bimetallic thermostat and the variable resistance.

For high temperatures the ability of the resistance muffle shown in Figure 2 cannot be doubted. It only takes a few seconds to reach maximum temperature and can be regulated quite easily. The only disadvantage I found is the capacity of just one crucible at a time, but this is no hindrance to its usefulness.

In many organic and inorganic reactions a temperature constant to within one of two degrees is essential.

Figure 1

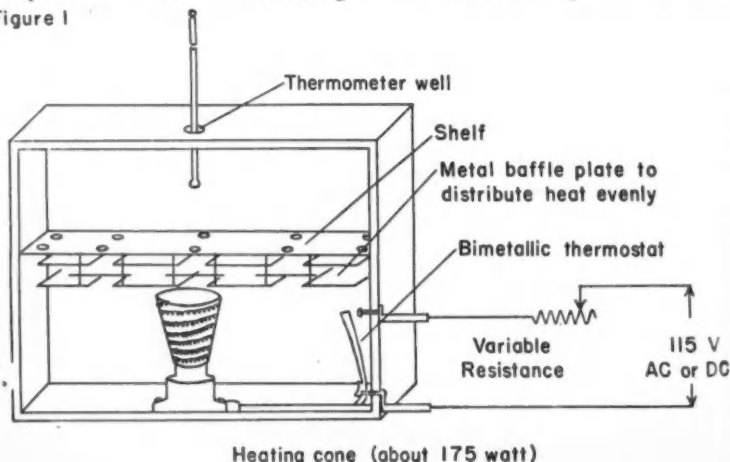
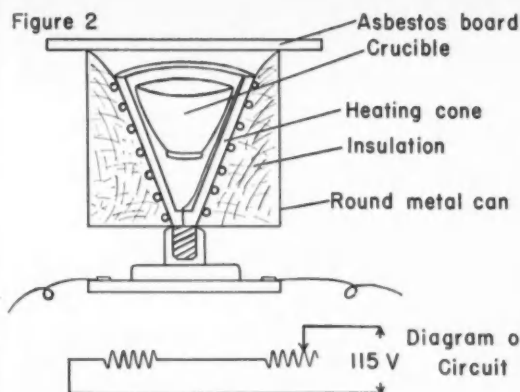


Figure 2



► HOLE is first cut in bottom of metal can, then heating cone is inserted and furnace insulation is packed around the heating cone. After this hardens it can be baked on by applying a low voltage to the resistance wire.

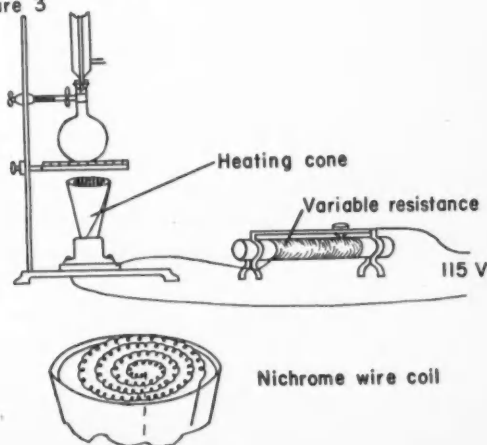
Lacking a hotplate of industrial design, the home chemist need not stop his progress. With the apparatus shown in Figure 3 a small voltage can be supplied to the heating element and can be controlled accurately to give an even heat. Shielding or insulation

of the complete assembly gives more precise control.

The three pieces of equipment have proved invaluable to me and I assure you that they are well tested and really work.

ALOYS L. TAPPEL

Figure 3



► HEATING CONE is converted to throw heat upward and variable resistance is used to adjust temperature. Nichrome wire is placed as a spiral on top of asbestos which completely fills the ceramic cone.

## Seeking Science Talent

► THE SIXTH ANNUAL Science Talent Search contest for the Westinghouse Science Scholarships closed on December 26, breaking records in number of entries. About 16,000 scientifically minded high school seniors throughout the nation took part in this annual search for science talent conducted by Science Clubs of America.

The objectives of the Science Talent Search as presented by Watson Davis, director of Science Service, are:

1. To discover and foster the education of boys and girls whose scientific skill, talent and ability indicate potential creative originality and warrant scholarships for their development.

2. To focus the attention of large numbers of scientifically gifted youths on the need for perfecting scientific and research skill and knowledge as a contribution to American and world progress.

3. To help make the American public aware of the varied and vital role of science in world affairs and everyday life.

Contestants must clear specific hurdles that have been set up to select the most talented youths with creative research ability. A three-hour super-stiff science aptitude test, designed to discover a student's ability to think and reason rather than to measure his acquired knowledge of science, is the first hurdle. In addition, each contestant must submit his scholastic record, recommendations from his school faculty and top off his entry with an essay on the subject "My Scientific Project."

The judges of the Science Talent Search will name 300 entrants for honors and Science Clubs of America will report the honors they have won to colleges and universities of their choice.

The top 40 contestants will be invited to the Sixth Annual Science Talent Institute in Washington, Feb. 28 to March 4. They will learn about new developments in science, meet prominent scientists and be introduced to the possibilities for their future in scientific research. During the Institute the judges will award \$11,000 in scholarships among these 40 boys and girls.

This year 10 states are holding State Science Talent Searches to discover outstanding science students within these states. These are patterned after successful ones held in 1946 by the Virginia and Tennessee Academies of Science. Through a cooperative arrangement between these states and Science Clubs of America, both National and State Science Talent Searches run concurrently. The records of the contestants are turned over to the State Science Talent Search Committee for review after the Sixth Annual Science Talent Search is over.

The individual State Science Talent Search brings together scientists, industrialists and educators in the process of discovering and developing science talent within the State. It is also instrumental in interesting colleges and universities in offering scholarships to the boys and girls chosen as winners in their home state.

## Synthetic Elastics

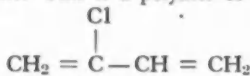
by JAMES WILLIAM SHIELDS, 16

St. Ignatius High School, San Francisco, Cal.

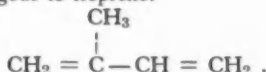
► SYNTHETIC elastics, as distinguished from thermoplastics, are of three principal types: elastomers, elastenes, and thioplasts. The first type is perhaps the most interesting as to chemical intricacy, the second as to industrial process, and the third as to research possibilities.

Elastomers are high-molecular weight polymers of a number of interesting compounds. Although natural rubber molecules are composed of isoprene units, no successful duplication of the long-chain structure found in Hevea latex has ever been made in laboratory or industry.

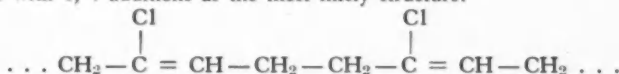
The synthetic matching natural rubber most closely in formula is the Dupont material Neoprene. This is a polymer of chloroprene:



a substance closely analogous to isoprene:



However, upon ozonolysis Neoprene yields succinic acid, indicating a straight chain with 1, 4 additions as the most likely structure:

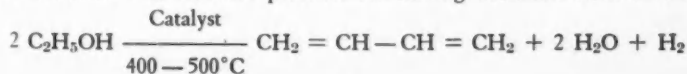


while natural rubber yields no such oxidation product; in fact, its exact structure is still disputed.

Another elastomer of considerable interest is polybutadiene:



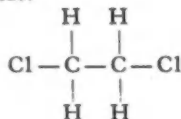
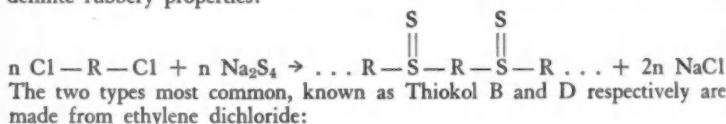
For a number of years this was the most successful synthetic elastic on the market. Even now it forms the basis for the Buna rubbers, which are copolymers of butadiene and other materials, chiefly styrene and acrylic nitrile. The manufacture of butadiene was the subject of a heated controversy in 1942, when alcohol interests demanded that the Government commence operation of the Publicker or Lebedev processes for making butadiene from ethanol:



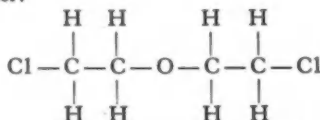
These processes are very interesting, especially the latter, which I have made the subject of considerable research.

Elastenes are polymers of butene-2 and similar non-conjugated olefins. Their structure and chemistry are relatively simple, but their manufacture is carried out under conditions of temperature and pressure which cause extreme difficulty both in laboratory and industry. Since my researches were carried out with an eye to laboratory practice, I spent comparatively little time upon this group of elastics.

The thioplasts represent a very unusual type of elastic. Their only connection with the rest is the similarity of their physical properties. Even less is understood about them than about other elastics. They are formed by the reaction of an organic dihalide with sodium polysulfide, in aqueous phase, with the resultant formation of salt and a latex of a long-chain molecule with definite rubbery properties:



and dichloroethyl ether:



Their adaptability to synthesis with processes and facilities at my disposal convinced me that this was the ideal field for my experimentation.

A principal difficulty with laboratory work on most synthetic elastics is the fact that their production involves gas-phase work. I had even commenced work on an acetylene  $\rightarrow$  vinylacetylene catalytic polymerizer for the Nieuwland polychloroprene synthesis, when the many difficulties which became apparent in handling gas phase forced me to abandon the project. On the advice of the head of the University of San Francisco Chemistry department, I decided to stick to liquid phase, and on his recommendation took up work on the synthesis of dimethylbutadiene.

Since the end of the last century 2, 3, -dimethyl - 1, 3, -butadiene (DMBD) has been known as the source of a synthetic elastic. The diene is a liquid boiling at c. 70°C., and polymerizes spontaneously or with mechanical and/or catalytic aid to a rubber-like substance. This was the "Methyl Rubber" pro-

duced by Germany in World War I; a substitute so inferior that all experimentation with it was apparently dropped when natural rubber again became available. It was not this elastomer that interested me when the idea of synthesizing DMBD was suggested, but the possibilities of the hydrocarbon in a thioplast.

Neither ethane nor ether has the conjugated double bond which is characteristic of elastics. For this reason the rubber-like properties of Thiokol's B and D are very surprising. The interesting question arose: What would be the nature of a compound which had in addition to the thioplast linkage the double-bond structure of an elastomer? With this question in mind, I set to work.

The synthesis of a thioplast such as I had in mind divides itself into four steps:

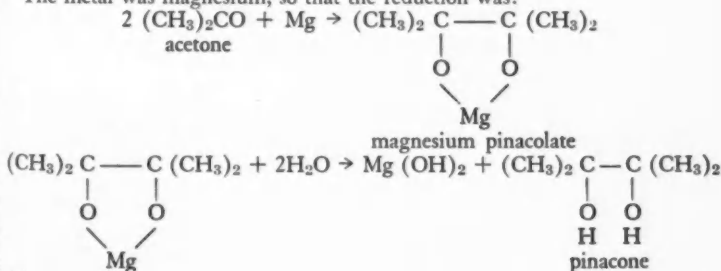
1. Preparation of pinacone from acetone.
2. Dehydration of pinacone to DMBD.
3. Chlorination of DMBD.
4. Reaction with  $\text{Na}_2\text{S}_4$  to form thioplast.

#### STEP 1. Preparation of pinacone.

Acetone is reduced by alkali metal to a pinacolate: the pinacolate is treated with water to form metallic hydroxide and pinacone: pinacone is precipitated as crystalline hydrate by addition of more water: hydrate is heated to  $115^\circ$  to leave pinacone.

The method I used followed closely that given in *Org. Syn.*, V., 87. The chief deviations were in quantity —  $\frac{1}{4}$  scale was followed — and in time — only 2 to 3 hours were available, 4 days a week, to work in the laboratory, so lengthy reactions were left overnight or over weekends.

The metal was magnesium, so that the reduction was:



The procedure:

20 g. magnesium turnings and 200 cc. benzene (anhydr.) were placed in the reaction flask and a solution of 22.5 g.  $\text{HgCl}_2$  in 100 g. acetone added slowly. When visible reaction stopped, 50 g. acetone in 50 cc. benzene were added. Mixture was left overnight. The next day a large dark-gray mass of

pinacolate was found in the flask. This was heated until the acetone refluxed vigorously. 200 cc. water were added and the mixture left overnight. A gray paste of  $Mg(OH)_2$  was found in the flask, and on top of it a mass of pinacol hydrate. The latter was dissolved by heating, the liquid suction-filtered off, distilled to  $\frac{1}{2}$  volume, and the hydrate reprecipitated by adding 300 cc. of water to the benzene liquor. The yield was about 70 g. of beautiful colorless hygroscopic crystals. These were heated in an open flask to a vapor temperature of  $115^\circ C.$ , and the residue taken as pinacone. The process was repeated with the following differences:

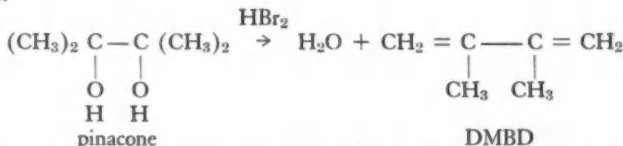
1. The initial reaction was left in a corked flask, which boiled over causing loss of about  $\frac{1}{3}$  of the reaction mixture.
2. Only 30 cc. of water were added to the pinacolate.
3. The hydrate was carefully distilled through a fractionating column to a final vapor temperature of  $140^\circ$ , care being taken to insure minimum loss of pinacone in vapors.

The net yield from the two experiments was c. 25 g. of a clear, yellow-brown liquid with viscosity of light oil, taken as pinacone.

An attempt was made at this point to produce pinacone dichloride by heating the pinacone with  $PCl_3$ , but the only result was to dehydrate it to pinacolone.

#### STEP 2. Dehydration of pinacone to DMBD.

Pinacone is dehydrated catalytically by the action of  $HBr$  to dimethylbutadiene:



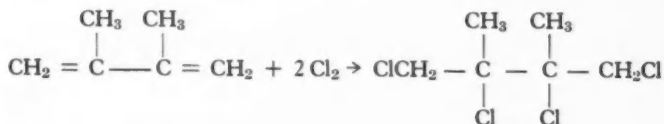
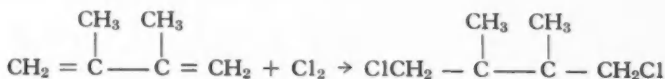
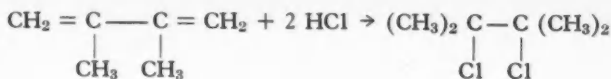
The method was essentially that given by L. P. Kyriakides in *J. Am. Chem. Soc.* 36, 993 (1914). The process:

15 g. pinacone, in benzene solvent, were distilled to  $90^\circ$  with 1 g. 4.8%  $HBr$  (equals .1 g. 48%). Distillate was dried over  $CaCl_2$ , redistilled without a column to  $80^\circ$ ,  $75^\circ$ , and  $72.5^\circ$  successively, the residue of each distillation being rejected. The final product was about .5 g. of a clear, oily liquid boiling from  $67$  to  $72.5^\circ C.$  (Compare Kyriakides,  $69^\circ - 71^\circ C.$ ) consisting principally of dimethylbutadiene. This quantity was too small for further work, but I intend to proceed with the remainder of the experiment as outlined here.

#### STEP 3. Chlorination of DMBD.

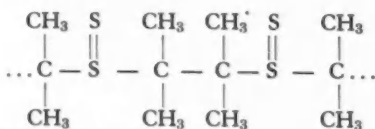
The liquid diene would be impregnated with either chlorine or hydrogen chloride at about  $50^\circ C.$  and distilled to obtain either pinacone dichloride, or the diene di- and tetrachlorides:



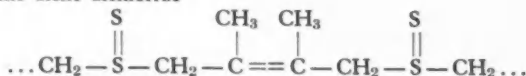


STEP 4. Reaction with  $\text{Na}_2\text{S}_4$  to form thioplast.

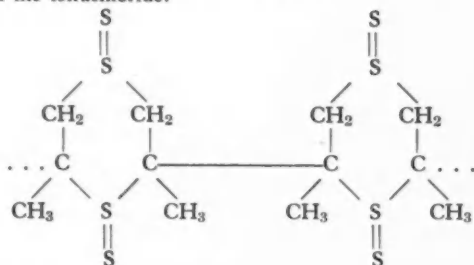
The chloride would be changed into an aqueous solution of sodium tetrasulfide and the thioplast latex coagulated. Three types of thioplast would be formed, one from the glycol dichloride:



one from the diene dichloride



and one from the tetrachloride:



It is my intention to investigate these materials and their properties as far as possible.

## *Organic Cements Bond Metals, Fabrics, Plastics*

► HUNDREDS of uses for a bonding cement, which once played an important role in war equipment, are suggested, from holding metal plates together without rivets or welds, to replacing needles and thread in the garment-making industry. It is a new synthetic organic cement developed in the laboratories of the Goodyear Tire and Rubber Company, and can be used to bond wood, plastics, rubber, fabrics, and metals together or to each other in any combination.

This cement, called Pliobond, forms a bond that is flexible, waterproof and possessed of high tensile strength. It retains these characteristics at temperatures ranging from 70 degrees below zero Fahrenheit to 140 degrees

above. It is easily applied and adheres at once to any clean, dry surface. It withstands high humidity and salt spray.

A bonding agent with similar properties has been developed also by the B. F. Goodrich Company. It is a new rubber cement, called Plastilock, which is a non-thermoplastic, water and aromatic oil-resistant adhesive for bonding metals, wood, plastics and ceramic material to themselves or to each other. In use better results follow when it is applied with heat and pressure. The purpose of the pressure is to obtain good surface contact. In an attempt to pull apart aluminum and wood held together with this material, the bond proved stronger than the wood itself.

## *Color Reagents Speed Chemical Analysis*

► COLOR "DETECTIVES" that simplify and speed up the chemical analysis of such substances as milk, metals, beer, wine and soap have been perfected in stable form at the University of Illinois. The "detectives" are chemical reagents that have long been known in chemical laboratories, but because of difficulties involved in compounding them have not heretofore been looked upon as stable and positive tools of chemical analysis.

Chemically the reagents are known as ortho-phenanthrolines. They are so efficient that they are able to disclose the presence of one part of iron, or certain other elements, in a million parts of water. The new development at the university chemical laboratory is a process of producing the reagents as

stable compounds capable of giving reliable reaction. Their use will permit an industrial chemist to make in 15 minutes certain analysis that under old methods might take a half day.

Phenanthrolines have the property of combining with electrically charged atoms known as ions. Their affinity for metallic ions is so great, according to G. Frederick Smith of the University chemical staff, that three molecules of one of these compounds will combine with one ion of iron, producing an intensely red water-soluble compound.

The reagent also has an affinity for copper, nickel, chromium, cobalt, zinc and other metals, and with it the presence of these metals in water, or in alloys, or in food products, can be detected.

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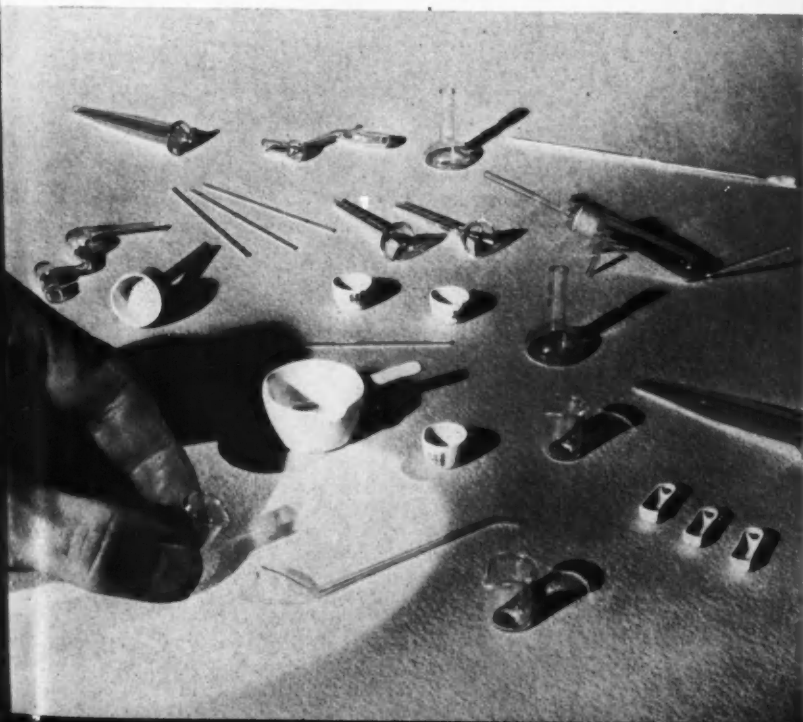


## Tiny

➤ EQUIPMENT for a microchemical laboratory can easily be carried in the palm of the hand.

➤ In these beakers, evaporating dishes and flasks, and such

elaborate pieces as retorts and stills on a midget scale, Westinghouse Electric Corp. chemists tackle problems of film and tarnish on electrical and magnetic equipment. Not all industrial equipment is huge.



## Identifiable Atoms Now Ready For Tracing Life Reactions

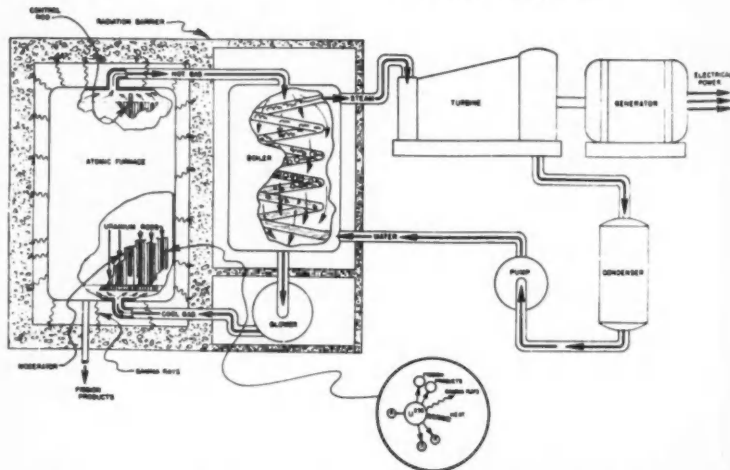
# Research With Carbon Isotopes

➤ BASIC RESEARCH which may some day lead to an understanding of the fundamentals of life itself has been started with radioactive carbon isotope 14 at the University of California.

Four shipments of the precious research tool produced in the atomic piles of the Monsanto-operated Clinton Laboratory of the Manhattan Engineer District at Oak Ridge, Tenn., were received recently, the first to arrive under a nation-wide distribution plan.

Laboratory work in as many fields was started immediately. Described as the most promising tool for unfolding the elementary processes of living things, radioactive carbon can be traced in tissues and chemical substances by means of its radiations.

With researchers all over the nation receiving the substance in relative quantity from the atomic pile, biological scientists await with keen anticipation the first results of work with radioactive carbon.



➤ ATOMIC POWER will be generated in a plant of this general design, according to Dr. Charles Allen Thomas, vice president and technical director of Monsanto Chemical Co., and project director of Clinton Laboratories, Oak Ridge, Tenn., which Monsanto operates for the government. This projected atomic power pile will mark man's first effort to harness the atom for constructive purposes. Radioactive isotopes are by-products of the fission process.

Dr. D. M. Greenberg, professor of biochemistry, will use the radioactive carbon he received to study heretofore hidden mechanisms involved in the synthesis and breakdown of proteins, the basic building blocks of living tissue. Dr. Greenberg will try to determine how both normal and abnormal cells grow, striking at the heart of the cancer problem.

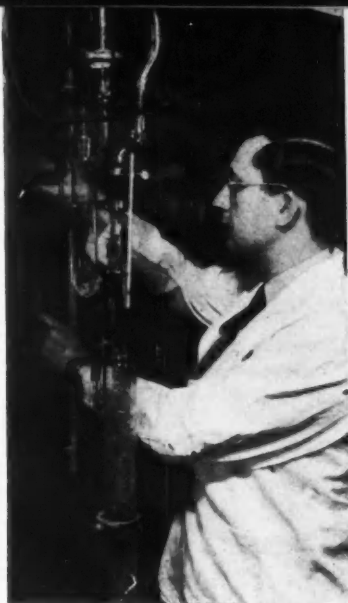
Dr. A. P. Krueger, professor of biochemistry, will use the millicurie of radioactive carbon he received in his study of the airborne transmission of respiratory diseases.

Dr. I. Chaikoff, professor of physiology, will investigate what happens to the fat molecule in the body, by labeling it with radioactive carbon. The fat molecule is intimately tied in with basic problems of metabolism.

Dr. William Dauben, instructor in chemistry, will use his shipment of radioactive carbon to study the metabolism in the body of anti-malarial pharmaceuticals developed during the war.

At the same time, availability of carbon isotope 13, of which a quantity was recently shipped for the first time by Kodak Research Laboratories in Rochester to New York's Memorial Hospital, will make it possible for research scientists to tag the carbon on two sides of a chemical or physiological reaction.

This may speed understanding of what happens in cancer, which is the main research problem at Memorial Hospital. Carbon of weight 13, produced by a chemical exchange method, may be used so as to supplement the radioactive carbon 14, made in the chain-reacting pile at Oak Ridge.



► DR. DAVID W. STEWART of the Eastman Kodak Company's research laboratories at Rochester, N. Y. makes an adjustment at the base of a fractionating column. In this column, four stories high, carbon 13 is concentrated in strengths as high as 20 per cent. Eastman has recently shipped its first batch of the heavy isotope, in the form of 12 grams of potassium cyanide, containing one-half gram of C-13, and will soon be making a variety of other compounds containing this form of carbon.

The possibly divergent paths of two carbon atoms introduced as a single compound may perhaps be traced by use of these isotopes. Their ultimate use may then be learned by identifying the isotopes in the tissues and distinguishing them from ordinary carbon, whose weight is 12.

## New Machine Replaces Radium, Takes Sharper X-Ray Pictures

### "Baby" Betatron

➤ RADIATIONS equal to three grans of radium are produced at one-tenth the cost of radium by a four-million volt, "baby" betatron built at the University of Illinois.

Smaller and simpler than the push-button controlled 20-million volt betatron developed there, the new device is expected to be used for X-ray work in science and industry.

It can be used in place of radium for taking X-rays, but has the advantage of an initial cost only one-tenth that of the radium to produce equal energy, declared Prof. Gerald M. Almy, who headed work on the new betatron.

The new machine is safer than radium, and concentrates its beam in one direction instead of all directions. Sharper X-ray pictures result from the betatron's pin-point beam that is more intense than any useful amount of radium, according to Prof. Almy.

Lone disadvantage reported was that the new betatron requires an operator in charge while it is running, where radium, once it is placed, requires no further attention.

The four-million volt device for science and industry consists of an electro-magnet, 15 inches wide, 25 inches long and 8 inches high,

mounted on a wheeled frame and arranged so that the beam can be swung up or down. The voltage is generated from a doughnut-shaped ceramic tube 8 inches in diameter that is located inside the hollow of the rectangular electro-magnet.

Electrons released from a glowing filament in the tube are accelerated by magnetic force and hurled against a tiny ray-creating target.

The power unit, connected to the magnet by a flexible cable, is kept at least ten feet from the betatron during operation, a safe distance for the operator whose control panel is on the power unit.

Prof. Almy claims the design is so simple that any laboratory machine shop can build a "baby" betatron, three of which have been built at Illinois. At least one other, made from the same plans, has been constructed at Ohio State University.

University of Illinois scientists are now working on a giant, 250-million volt betatron expected to produce cosmic ray effects.

Built during the war, the new betatrons were produced under the auspices of the Offices of Scientific Research and Development.

Tungsten and antimony obtained principally from China prior to the war, may be purchased permanently from Bolivia and Argentina because of improved methods of production in those countries that may lower the cost.

## Americium Isolated

➤ A THIRD of the synthetic, transuranic elements, americium, has been purified in sufficient quantities to permit a study of its chemical properties.

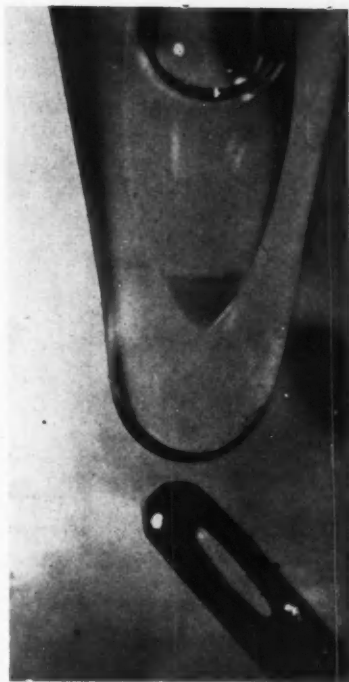
Americium hydroxide has been precipitated in large enough quantity to be photographed, in one of the capillary tubes used for research on the transuranium elements.

This was revealed by Dr. Glenn T. Seaborg, University of California nuclear chemist who was a leader in atomic bomb research, when he delivered the second annual Harrison Howe lecture to the Rochester section of the American Chemical Society.

Dr. Seaborg said that the work on americium, element 95, which was done by Dr. B. B. Cunningham at the University of Chicago Metallurgical Laboratory, was "a remarkable achievement in that the amounts available were even smaller than those in the case of neptunium and plutonium, the previously purified synthetic elements.

The scientist also revealed that curium 242, the heaviest isotope of any element so far reported, can be produced by the same chain-reacting pile technique used for obtaining plutonium. Instead of bombarding uranium with neutrons, it would be necessary to bombard americium with neutrons.

Curium is the only one of the synthetic elements not yet isolated in pure form, Dr. Seaborg pointed out. He indicated, however, that this may be possible if and when such isotopes as curium 243, 244, 245, or 246 are produced. Such isotopes, Dr. Seaborg



➤ AMERICIUM HYDROXIDE is the small amount of solid in the tip of the capillary tube, far below the meniscus of the drop of solution from which it was precipitated by Dr. B. B. Cunningham of the University of Chicago Metallurgical Laboratory. The eye of a sewing needle below the tube gives the scale of sizes for the ultra-micro-chemistry used in nuclear research.

said, may have longer lifetimes than the brief span of the curium isotopes now known.

**Research With Recent Alloys  
Overcomes Difficulties in Use**

## Magnesium in Aircraft Construction

► THE FULL POSSIBILITIES of magnesium in aircraft construction have not yet been realized, declared J. C. DeHaven, of the Battelle Memorial Institute at the National Aeronautic meeting of the Society of Automotive Engineers recently. Several laboratories, he said, have produced small quantities of experimental magnesium alloys with properties which, on a strength-weight basis, are superior to the highest strength commercial aluminum alloys.

There is still much to learn about these experimental alloys, he continued, and their commercial production may be a long way off; but there are propitious signs that many, if not all, of the increasingly stringent requirements of aircraft designers for a primary construction material may be met by magnesium.

The development of magnesium alloys as aircraft materials was reviewed by Mr. DeHaven. He put to rest the false story that the American aircraft industry learned about magnesium from the Germans. Through patent literature, as well as personal visits, the British and Americans were quite familiar with German practice up to the start of the war, he stated.

Examination of enemy planes during the war, he continued, indicated our magnesium technology was equal, if not superior, to that of the Germans, with the possible exception of large press forgings, which they were equipped to make and we were not.

Magnesium-base alloys have entered

the fold of aircraft structural materials only very recently, he said. There were a number of reasons for this late arrival. Magnesium was produced during the first World War largely for nonstructural uses, in ribbons and powder for flares and incendiaries. People were afraid of magnesium, he declared, and even metallurgists were not sure that it was safe to have a bar of it indoors, in the event that it should burst into flame.

Of the structural forms of magnesium, sheet has presented the greatest flammability problem, he declared, because its thin section permits localized overheating and subsequent melting more readily under certain conditions of combustion. At least for the structural forms of magnesium, actual melting of the metal is required before any burning can take place. Recently, an alloying addition to magnesium has been developed which exhibits a remarkable inhibiting effect on the burning characteristics of the metal. With it magnesium sheet is not affected to an appreciably greater extent than steel sheet.

Excessive corrosion of magnesium was another obstacle to be overcome. By production control methods, he explained, it is now possible to keep the impurities in magnesium alloys to such a low level that present-day wrought magnesium alloys are extremely resistant to ordinary atmosphere corrosion and also to salt atmosphere.



## Physicists Attack Mystery At Heart of Atom Structure

# Electrons Linked by Protons

by WATSON DAVIS

► A NEW EXPLANATION of science's most fundamental relationship, the way in which light interacts with electrons, the particles of electricity, was presented to the world when Dr. P. A. M. Dirac of the University of Cambridge, England, spoke at the Princeton Bicentennial Conference on Nuclear Science.

Dr. Dirac told how a combination of Einstein's special relativity theory and the Heisenberg uncertainty principle gives hope of explaining the way in which two electrons get together by passing between them a bundle of light that scientists call a photon.

In his audience of about 50 was Dr. Niels Bohr, the Danish atomic scientist, as well as other world leaders in atomic studies.

Despite the world-shaking consequences of atomic physics, scientists have not been able to figure out vigorously and precisely the relationship of two electrons, the smallest bits of matter, even when only the simplest and most classical conceptions are included.

Dr. Dirac explained that his latest solutions of what is called "the quantum theory of electrodynamics" give mathematical results that predict what is discovered by experiment without resorting to arbitrary rules in the mathematical developments.

Such complex equations may seem theoretical and remote, but in them

there may be the beginnings of new understandings of cosmic rays, of interplay between the constituents of atoms, of new phenomena that promise new industries and new weapons for the future.

The importance of having a good method of solving what happens when two electrons interact extends far beyond this simple case. It is the first step to understanding what happens when the cores of two atoms interact. The clash of atomic nuclei powers an immense amount of human endeavor including atomic energy.

By use of analogy, with a dash of intuition, the theory concerning simple electrons is being applied to atomic hearts to explain their interaction. Just as packets of light are connections to the electrons, there is a possibility that the meson particles discovered in cosmic rays are means of interchange between the constituents of atomic nuclei.

The idea that there are regions of the universe very close to the cores of atoms where rules that are good in the larger spaces outside do not apply was recalled into the scheme of things by Dr. Dirac. This is a sort of "two worlds" type of physics that seems to be necessary to make theory work and most physicists are no more happy about it than the advocates of one world in the present international situation.

As stated by Dr. R. P. Feynman,

young theoretical physicist from Cornell, who discussed the Dirac paper, studies of the cosmic rays being pushed by V-2 rockets and B-29 flights promise to give facts that can be applied to deciding what mathematical pictures of the atomic world are correct. From the new experimental high voltage generators being built in several American laboratories, more information will be obtained. They will duplicate the energies of the cosmic rays under experimental control.

### *High School Students Favor Control*

► ATOMIC ENERGY CONTROL and a powerful world government are essential for future peace and our survival, in the opinion of three-fourths of the nearly 10,000 high school pupils queried in a survey reported to the American Association for the Advancement of Science meeting in St. Louis recently by Drs. H. H. Remmers and K. S. Davenport, of Purdue University.

Concern of America's boys and girls over this major international question is clearly shown by the survey, which was conducted in 13 states.

Half the students disapprove of the continued manufacture of atomic bombs by the United States and only 39% approve of this policy. A little more than half (54%) would not approve of turning over the manu-

The new 184-inch cyclotron at the University of California will also make possible the discovery of many more artificially radio-active isotopes of chemical elements in addition to the 450 now known. Dr. Glenn T. Seaborg, discoverer of the atomic bomb element, plutonium, told the conference this new atom smasher, to begin operating this fall, will generate heavy hydrogen particles of 200,000,000 electron volts and helium ions of 400,000,000 electron volts.

facturing secrets to UNO and 64% are opposed to giving the "secrets" to Russia.

Responsibility of the United States Government for future scientific development is recognized by the high school students questioned. Eighty-three per cent said they believe the government should provide financial assistance for the training of future scientists; 91% feel that the government should spend as much for medical research as it did for atomic research.

With regard to the peacetime development of atomic energy, three-fourths of the students believe that the control should be in the hands of the government; only 20% indicated in answers to another question that private business should control this source of power.

Much asbestos is produced in Canada but little processed for use there; it is exported chiefly to the United States to make fire-fighting clothing, automobile brake linings, steam pipe coverings, and for other fire and heat protection uses.

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